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TUBE TEETH AND
PORCELAIN RODS

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BY

JOHN GIRDWOOD

D.D.S., UNIVERSITY OF PENNSYLVANIA
L.D.S. EDINBURGH

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PREFACE

A LARGE part of the subject-matter of this book has appeared in a series of papers contributed to the "Dental Cosmos" during 1914–15; and the amount of interest which has been shown in the methods and ideas which were brought forward appears to offer sufficient justification for presenting them in more permanent form.

A great deal of new matter has been added, and all the papers have been rearranged in order to simplify the presentation of the subject; but an exception to this will be found in the Introductory Chapter, on which few alterations have been made, and which sets forth some of the principal reasons which have caused the book to be written. There are others, which need not be enumerated here, but which will be apparent to those who are sufficiently interested to follow the text.

The literature dealing with the subject of Prosthetic Dentistry grows rapidly, more especially that part which deals with the subject of crown and bridge work, but a study of the most recent works which deal wholly or in part with crown and bridge work, does not reveal any marked advance. The new material which appears deals mostly with certain new types of teeth and crowns, nearly all of which are modifications of the old form of tube teeth. This process of multiplication and modification of crown forms has been going on for the past quarter of a century, and is leading to much confusion, unneces-

sary trouble, and expense. Moreover, these individual forms of crowns have a very limited range of usefulness even when they are supplied in a large range of sizes, shapes, and colours; whereas the ordinary forms of tube teeth meet the needs of nearly all cases, and a limited selection of the special forms of tube teeth and porcelain rods will provide the materials from which, with very little trouble, any form of detached-post teeth or crowns can be quickly formed.

In suggesting a revival in the use of tube teeth it cannot be laid to the writer's charge that he is adding another tooth to a list which is already too long, as the tube tooth was the earliest form of porcelain tooth, and has been in constant use up to the present time. The same cannot be said of the suggested revival in the use of gum tube teeth and sections, as these latter have not been manufactured for the past 40–50 years, and so have not been procurable; therefore they may be looked upon as a fresh addition. Experience has proved that they would amply justify their adoption, particularly in connection with the casting process, while they have also been found superior to the ordinary forms of gum teeth and sections for other classes of prosthetic work.

Porcelain tube rods and blocks are a new form of the raw material from which tube teeth, crowns, bridges, etc., may be readily formed, and it is hoped to make clear the many uses to which they may be applied. Probably their usefulness is most marked in bridge work, and for teaching purposes. In regard to the latter, they offer advantages possessed by no other material for the purpose of obtaining

that artistic skill which is so lacking in our work, and which present methods do little to stimulate.

Considerable space has been devoted to grinding materials and methods, as these subjects have hitherto attracted less attention than their importance seems to warrant. The time taken to shape up many of the specimens illustrated has been given, and careful descriptions of the wheels used. This has been done with the object of showing that by the use of suitable wheels grinding is made easier and quicker.

The difference in the time taken to shape up apparently similar specimens is accounted for by the difference in the amount of experience and skill of the individuals who prepared them. Some of these trials of skill have been made by pupils whose first attempts are shown; and a wide experience has proved that little practice and no special skill is necessary in order to obtain excellent results in this work.

The illustrations speak for themselves and are the work of my friend D. Robertson Campbell D.D.S. (University of Pennsylvania), who had the able assistance of his brother MacArthur Campbell who also studied there. To the former I am particularly indebted, not only for the beautiful photographs, but also for very valuable assistance in other ways, including the work of correcting proofs. I am also greatly indebted to my partner Mr. T. R. Calder for the sketches illustrating the text, and for many of the specimens which he has made. My thanks are also due to my London partners for valuable help, also to my mechanical assistants and pupils, who have shown much diligence and enthusiasm in

duplicating cases in practice, and in making other specimens. To Messrs. C. Ash, Sons & Co., Ltd., London, I am under special obligation for their kindness in undertaking the manufacture of the special forms of tube teeth and porcelain rods, and other materials best suited for this work. My thanks are also due to Messrs. Lemale & Co., London, for specimens of old-time forms of tube teeth and gum tube teeth and sections; also to the S. S. White Co., for plates illustrating some of their instruments, and to the Ritter Manufacturing Company for a cut of the Columbia Lathe.

J. G.

Edinburgh and London.

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TUBE TEETH

CHAPTER I

INTRODUCTORY

WHILE it is impossible to produce evidence of when and by whom the first tube teeth were made, it is fair to assume that they were among the earliest forms of porcelain teeth employed in dentistry. Anyhow, there is presumptive evidence for the reasonableness of this conclusion when one remembers that one of the earliest methods of tooth substitution and replacement was the use of the natural teeth fixed either upon the root of a tooth or on a base or plate, and that the general mode of attachment of these teeth to the natural roots or artificial base was by means of a pin or post passing through a hole or tube formed in the tooth, which was carried either through the body of the tooth entirely to its grinding or occlusal surface, or sufficiently far to admit of a strong enough post to hold the tooth secure in its place. Indeed, one of the earliest records of a pivot tooth, or as we now call it, a crown, is to be found in Fauchard's work "Le Chirurgien Dentiste; ou, Traite des Dents," published in 1726.

It is, however, certain that M. N. Dubois de Chemant, a Paris dentist who practised in that city in 1788, and who was one of the pioneers in the

making of porcelain teeth, by some means came into possession of the process of an apothecary of St. Germain named Duchateau, who in 1774 was led to study the subject of porcelain teeth by the "unbearable condition of his own artificial teeth of bone," and who communicated his discovery to the Academy of Surgery in 1776. Duchateau's invention seems to have fallen into disuse until taken up by M. N. Dubois de Chemant, who took out a patent for the process of making artificial dentures and teeth of mineral paste, to which he applied the name of "incorruptible." Duchateau formally claimed priority of invention, but lost the case, and De Chemant, failing to popularise the new production, removed to London, where he obtained the exclusive right of working the invention for twelve years. He published various editions of his work, the first apparently in 1788. An illustration from the fifth edition is given in the S. S. White Catalogue of Porcelain Teeth, where also may be found much valuable information regarding the early history of these teeth.

In De Chemant's work, "Dissertation on Artificial Teeth," published in London in 1804, appears the first description of tube teeth (page 34, 4th edition): "in the teeth of unalterable mineral materials, the holes which receive the pivots are square, and cannot become larger, which renders them very firm, and besides, as they are riveted they can never separate from the teeth. I can even solder them to the artificial pieces when necessary."

From this it would appear that De Chemant must have made teeth with square tube-holes through which passed square posts attached to the artificial

denture, enabling the teeth to be riveted on their occlusal or lingual surfaces; or the teeth might first have the post fixed in them by riveting the occlusal or crown surface and the base soldered to the plate. Like most old-time authors, De Chemant tells one everything except "just how to do it."

In America tube teeth were first manufactured in 1822 by Mr Charles W. Peale, who practised dentistry in Philadelphia. He was soon followed by many others, and by 1838 mineral teeth had come into general use both in America and Europe. Among the pioneers in the former country were Samuel W. Stockton in 1825, D. C. Ambler of New York and J. R. Spooner of Montreal in 1828, and in 1837 Elias Wildman of Philadelphia and Dr J. A. M'Ilhenny, both of whom did much to further the improvement in the manufacture of porcelain teeth. These workers made single tube teeth, or curved blocks with tubes through them to take gold rivets, whereby the teeth were attached to the plates; but these were discontinued for insufficient reasons, as were also curved tube blocks, though these latter were in use for a much longer period, in fact until the introduction of vulcanite. At the same time, it is probable that neither the single tube tooth, gum tube tooth, or gum tube sections were manufactured except by practitioners for their own use.

The history of tube teeth in England is associated with the early beginnings of Messrs Ash, Sons & Co., and Messrs Lemale & Co., both of London, (Figs. 1 and 2), who commenced the manufacture of tube teeth in 1837 and have continued to carry it on up till now. These were made for use in plate work, though they were occasionally used for crowning

the upper front teeth, and were made with a metal tube baked in the body of the tooth and the mode of attachment both in crown and plate work was by means of a metal post. There is no evidence to support the statement made by some writers that pivots of hickory wood were employed. In fact

FIG. 1. Specimens of tube teeth. (Ash, Sons & Co., London.)

the small size of the tube prevented it from being used in this way, and obviously those who have been responsible for this statement have confounded the old wood pivot tooth (which is, of course, a form of tube tooth) with the English tube tooth. From 1837 to 1855 gold was used for the tube. At a later date platinum was used because it allowed

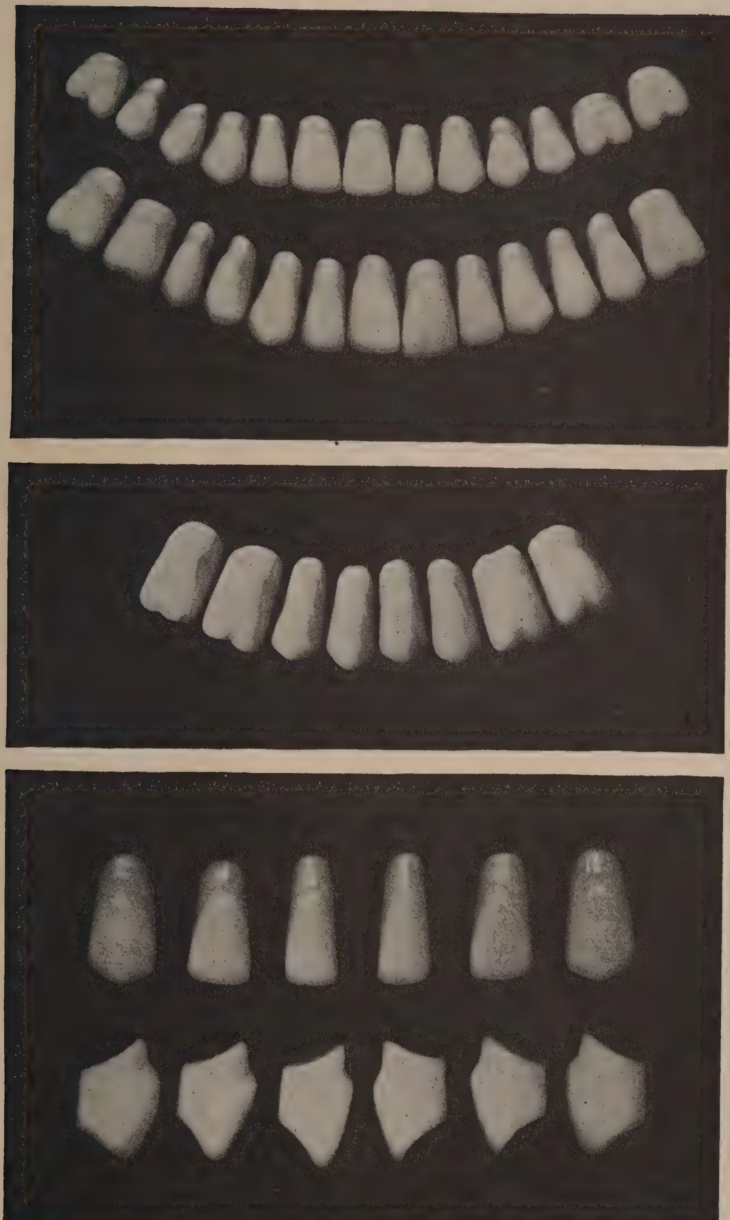


Fig. 2. Specimens of tube teeth. (Lemale & Co., London.)

of a higher temperature in firing the porcelain, and at that time it was much cheaper than gold. It seems strange that one of the reasons why platinum should displace gold for tubes was on account of its price, but, when one considers that at that time platinum was about $4.50 per oz., whereas now it is about $70.00, one ceases to wonder. The platinum tube was seldom an advantage in point of view of colour, because in a thin tooth it was apt to show through and produce a dull effect. Formerly one colour of porcelain only was used, and the body was more fusible and not so highly glazed. Coincident with the introduction of the platinum tube, however, two colours have been used. The principal reason for the use of the metal tube was that, at the time tube teeth were introduced, there was no cement on the market — only sulphur, which adheres to metal better than to minerals. It has since been found that, provided the glaze is thoroughly removed from the surface of the tube as is done in the modern non-platinum tube tooth, the attachment by means of sulphur or one of the cements is quite satisfactory.

Most of the old-time dentists in England continued to make their own supplies of teeth, both plain and gum, as well as gum sections up till about 1865. A few of them made single tube teeth with half-round platinum tubes which did not pass quite through the tooth: doubtless the half-round post was to prevent rotation, but this was quite unnecessary, and, as we shall see later, limited the usefulness of the teeth in other ways, and so the practice was discontinued.

While the tube tooth, better known as the English

tube tooth, is unfamiliar to many American dentists, its use has never been discontinued by the best class of British practitioners. Fortunately there are signs of reviving interest in these teeth; indeed, the surprising thing is that interest should have declined, and while the causes which have combined to displace tube teeth from favour cannot be accurately stated, generally speaking they are those which contributed to the decline in the use of single gum teeth or sections for plate work; and these causes were largely due to the introduction of vulcanite as a base. Coincident with the rapid advance in favour of this material was the increased demand for pin teeth. The manufacturers were in the position to take advantage of this demand. As the introduction of vulcanite extended the field of prosthetic dentistry, the dentists then in practice found they had more work than they could well overtake. They therefore gladly abandoned the irksome task of making their own supplies of teeth, and depended on the makers of artificial teeth who could furnish them with a better and cheaper article, and at the same time offer a wider selection. The result was a great and rapid increase in the manufacture of flat teeth, new types of which were quickly added, and as these could be used for all purposes, the enthusiasm for these new forms was shared by dentist and manufacturer alike.

It is surprising that the suitability of tube teeth for use with a vulcanite base or a metal base with vulcanite or other like attachment, was not realised till within the last few years, when many forms of teeth with a somewhat similar provision for anchorage were in use in connection with the Blandy and

other processes before the introduction of vulcanite. With regard to their use in plate work, there can be little doubt that the defective character of the grinding wheels then in use was also a powerful factor in helping to diminish the popularity of tube teeth, as these often called for much grinding and fitting. In consequence, the tube tooth fell into comparative obscurity.

The superiority of tube teeth and porcelain rods, both as regards the principle of their attachment and their practical application in the various classes of prosthetic work will be fully described and illustrated later, and it is hoped that this will do something to stimulate artistic as well as manipulative dexterity, and lessen the ever-increasing number of new forms of crowns now so persistently brought forward. This multiplication of forms is leading to much confusion and unnecessary trouble and expense. Moreover, these individual forms of crowns have a very limited range of usefulness, even when they are supplied in a large range of sizes, shapes, and colours. In fact, their use is practically confined to crown work and some cases of bridge work, whereas tube teeth and porcelain rods call for no more than a very limited selection of forms, sizes, and colours in order to supply the necessary materials for forming almost any type of tooth, crown, porcelain bridge, or gum tooth section, and with far better results, both artistic and mechanical, than are obtainable by any single type of tooth or crown, or probably by any combination of them.

The term "tube tooth" is employed here in connection with what is commonly known as "the English tube tooth," the description of which by

most writers is faulty and misleading, but the term "tube tooth" would with accuracy describe all the modern forms of detached post crowns as well as those dating from the introduction of the wood pivot crown (Fig. 3), from which some writers have dated the so-called modern improvements.

After all, what are the latest forms of detached post crowns but tube teeth? And to what else do they lay their claims to superiority over their fixed post rivals but to this very tube principle? This attachment as has been pointed out, consists of a pin or post[1] passing through a hole or tube formed in the body of the tooth. It is true that in most of the modern forms of detached post crowns the tube does not pass right through the tooth body, and this constitutes one of their principal weaknesses, as will be shown later. Suffice it to say meanwhile that ample proof is afforded of the endeavours which are being made to improve upon the tube tooth by adopting the principles while failing to appreciate one of its outstanding features which lies in the accurate fit of post and tube. In many of the standard works on prosthetic dentistry as well as some others, the

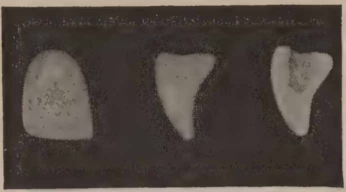


FIG. 3. Shows old form of pivot tooth commonly called wood pivot.

[1] When the tube tooth is referred to in crown or bridge work the term "tube crown" or simply "crown" is generally used instead of "tube tooth" as in plate or vulcanite work. When the term "post" or "dowel" is employed, it refers to its use in crown work, whereas when the term "pin" is used it refers to its use in plate work. The term "horizontal bar" or "horizontal post" is employed to describe the use of these in the manner indicated by these terms. Such "bars" or "posts" may be either solid or tubes and are frequently joined to vertical posts or tubes and often combined with inlays.

rise and progress in popularity of the pivot tooth or modern detached post crown is dealt with in order to prove that a great advance has been made in the design and manufacture of porcelain crowns; and in proof of this the old form of all-porcelain pivot tooth, commonly called the wood pivot (Fig. 3), which was much in use some 30–50 years ago, is made the starting point from which the advance is supposed to have taken place; but a careful study of what has been written, and of the crowns themselves does not carry the desired conviction. In fact some of those illustrated, one might venture to say all of them, show transition types which are markedly retrograde, and go far to prove that the old wood pivot tooth has never been equalled in point of form, strength, adaptability, or quality of porcelain, by any of the later forms of detached post crowns, although they are excelled by the tube tooth mainly on account of its superior adaptability.

Points to be noted with regard to the illustrations shown in Fig. 4, are the size and the position of the tubes and the deficiency in the thickness of porcelain mainly on the lingual surface of the incisor crowns.

As the tube tooth, therefore, is superior to any of the later forms of detached post and other crowns, and can be easily and quickly altered in substitution or replacement of any one of them, there seems no need to give a detailed description of the too numerous new forms which are constantly appearing. Moreover, men usually limit their requirements to one or two crown forms, and the literature provided by the makers of these usually gives more detailed instructions with regard to these than that which appears in most books dealing with crown

and bridge work. One of the many advantages to be derived from the use of tube teeth and porcelain rods is the increased facilities afforded for acquiring

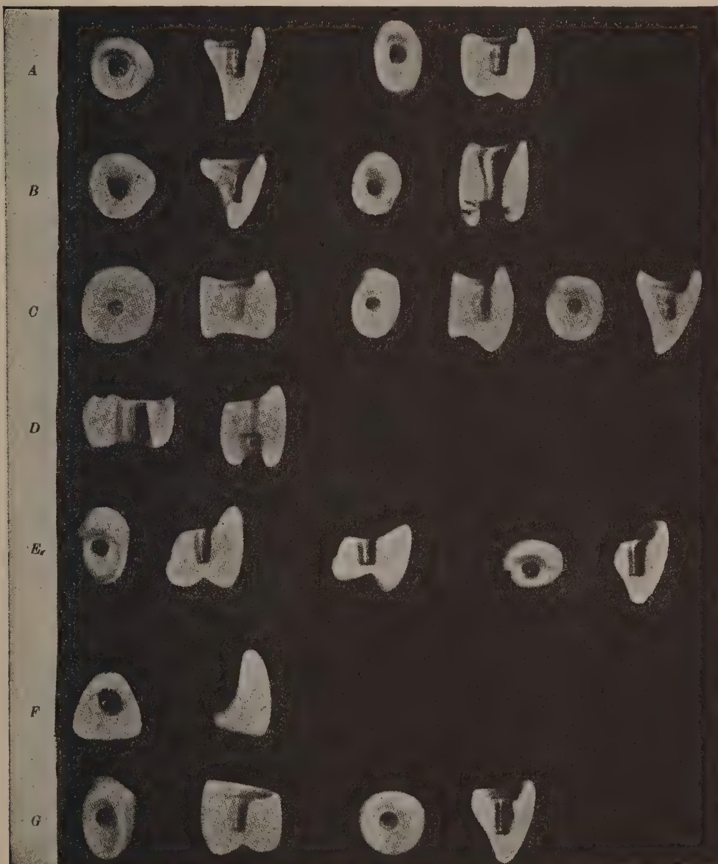


FIG. 4. Sections of some well known crown forms.

A, White's detached-post crown. *B*, Gates-Bonwill crown, *C*, Ash's dowel crown, *D*, How dovetail crown. *E*, Goslee crown. *F*, Foster crown. *G*, Davis crown.

artistic as well as manipulative skill, particularly on the part of the student, as it appears doubtful if there has been any advance in this direction in the

last twenty years. Doubtless this can be partly accounted for by the great increase in number of methods and appliances, most of which seem to have been designed with a view to simplification rather than thoroughness. As a result, students, and for that part of it practitioners also appear to be in danger of becoming mere assemblers of parts. In consequence their creative faculties are not sufficiently stimulated while their mechanical skill appears to make no advance; and this condition of matters does not seem to be confined to any single country, but appears to be universal. Those who interest themselves in various forms of craftsmanship outside of our profession, are well aware of the fact that the race of craftsmen who could design and execute a piece of work and complete it from start to finish, is now all but extinct; and there is danger of this happening in our profession where craftsmanship plays an important part. It would tax the ability of most men to equal the mechanical as well as the artistic excellence of work done half a century or more ago, specimens of which will be found in many of the collections of our universities and dental schools. For it must be remembered that the advance which has been made in the latter direction has been largely due to the skill and enterprise of the makers of artificial teeth. It is believed that the processes hereafter to be described will supply the necessary training with the minimum of time and trouble, and this would result from the use of tube rods for teaching purposes, as from them may be formed tube teeth, crowns, and bridges, all by simple methods which will be described.

In addition to tube teeth and porcelain rods, the

writer suggests a revival in the use of single gum tube teeth and gum tube teeth sections. These have not been manufactured for the past forty to fifty years, and so have been unprocurable. The employment of these in connection with the casting process would open up a new field in prosthetic work. It would permit of practically all the advantages derived from the use of continuous gum work being obtained in as simple and easy a manner as by the use of vulcanite with gum sections, and yielding far better results in most cases. In addition to their use in the manner suggested, they could with advantage be made to supersede the present forms of gum teeth and sections in vulcanite work, and doubtless they would once more attain the popularity which they enjoyed previous to the introduction of vulcanite as a base.

With regard to the manufacture of porcelain teeth in general, while makers claim that their teeth and crowns are better made than ever before, those of us who had the opportunity of using teeth made about thirty years ago, or very much earlier, and who are fortunate enough to have retained some of these old-time teeth, realise that their claims are not well founded. From the point of view of standardization of colour and the great increase in number of new shapes and forms, etc., there may be improvement, but for lifelike appearance and strength the older teeth were superior. These, indeed, might be termed "tougher," or less brittle. One of the reasons for this toughness was that the prevailing practice was to allow the teeth to cool down in the muffle until stone cold, seldom less than twenty-four hours being allowed for this cooling process. More-

over, a batch of teeth usually consisted of a few hundreds only, and not thousands as at the present day. Such a method was, of course, expensive, particularly as regards fuel. The stress of modern competition has resulted in quicker but less satisfactory methods of manufacturing and particularly of annealing.

CHAPTER II

FORMS OF TUBE TEETH AND PORCELAIN RODS

IN the introductory chapter claims have been advanced in favour of tube teeth as superior to other forms, and before proceeding to elaborate these, a fuller consideration of the materials at our disposal seems to be called for. These consist of: (1) Tube teeth with platinum tubes baked into them, and known as the old, or ordinary, forms of tube teeth; (2) Tube teeth without the platinum tubes; (3) Special forms of non-platinum tube teeth; (4) Special non-platinum single and double tube rods; (5) Special non-platinum tube curved blocks.

No. 1. — Tube teeth with platinum tubes may be termed the old style of tube tooth, which has been on the market since 1837, and up until 1856 was made of one colour of porcelain throughout. Since 1856 and up to the present time, they have been made in precisely the same way as all other forms of poured teeth. The internal diameter of the platinum tube is .06 of an inch, and the size of post should therefore be .056 of an inch.

No. 2. — Tube teeth without platinum tubes are formed by the insertion of pins in the moulds before the teeth are fired, and the tubes are afterwards reamed out true by means of a diamond reamer. The result is an unglazed tube which gives ample hold to either cement or sulphur, provided the glaze

has been completely removed from the porcelain tube, and it seems probable that in future only the non-platinum tube teeth will be called for. The body is formed of two colours, graduated from the neck to the cutting and grinding edge, as in other forms, and a large selection of shades is afforded. The internal diameter of the tube in the non-platinum tube tooth is .072 of an inch,

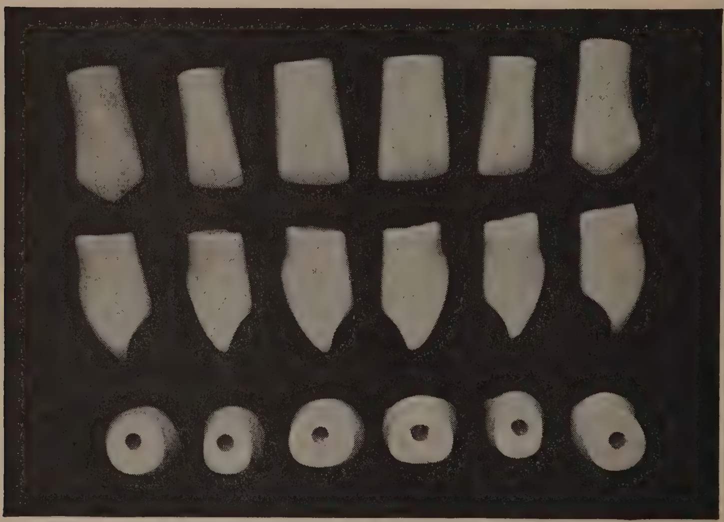


Fig. 5. Showing tube teeth too small in base for crown work.

and the size of post should therefore be .068 of an inch; in fact 13½ U. S. gauge is the proper size for pins or posts, and allows of ample strength while it does not unduly weaken the tooth as a larger size would do, particularly in the case of small lateral incisors. As a further guide to the exact size of this tube, it may be stated that the diameter of the tube in the platinum tube tooth *with the platinum tube extracted therefrom* is precisely the same size as that of the non-platinum tube tooth — in short,

that it is the platinum tube itself which makes the difference in size between the two. The post should always fit the tube accurately, but not tightly. Tube teeth with platinum tubes and non-platinum tube teeth both exhibit certain defects which will be seen by referring to Fig. 5, and which are most marked in the incisors and canines. Almost without exception the bases will be found to be too small. In consequence it is impossible in nearly all cases to cover the root completely when the aforesaid forms are used for crowning; but this defect does not preju-

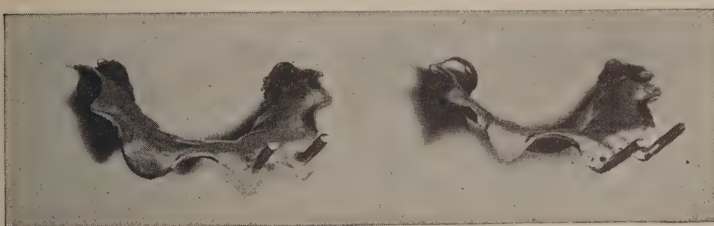


Fig. 6. Shows — A, Pin in correct position. B, Pin too near edge of plate.

dice their use to the same extent when employed in plate work, or when vulcanite is used as a base, as there is not generally the same necessity for a large body of porcelain as when a cap or root has to be covered. There are exceptions, however, such as when any or all of the front teeth have to be set on the gum, or where a single tooth has to be set between adjacent natural teeth. In such cases the smallness of the porcelain base of the tooth would necessitate the pin being soldered almost to the edge of the plate, with the result that the plate, when filed away sufficiently to conceal the gold, would be rendered too weak, and in consequence the pin would be liable to break off (Fig. 6). In these cases, there-

fore, it is better to use one of the special forms of broad-based teeth (Figs. 7 and 8), or they may be shaped up from porcelain rods.

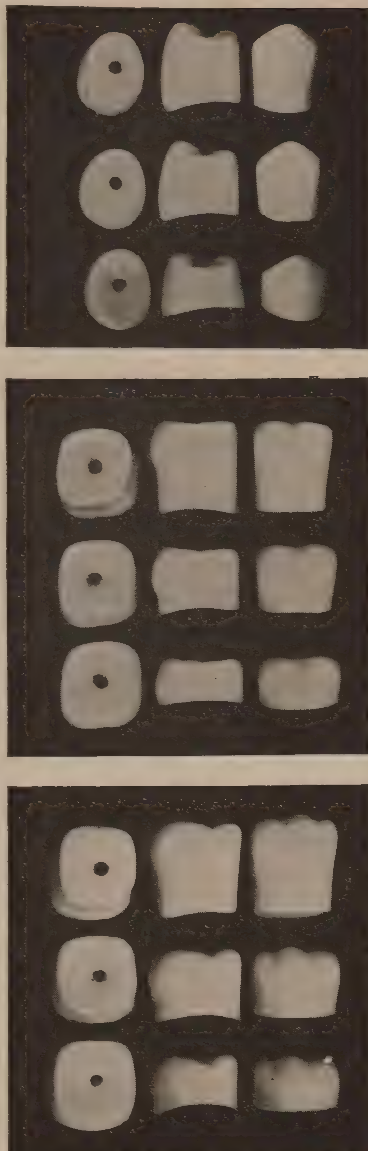
No. 3. — Special forms of bicuspids and molars were designed by the writer some twelve years ago to surmount the defects already spoken of, and they were made large enough in the base to cover most capped molar and bicuspid roots (Figs. 9, 10, and 11). These, used primarily for this purpose, came to be

Figs. 7 and 8 show special forms of broad-based teeth.

employed for supplying the raw material from which to form front tooth crowns (Fig. 12), but of course only the larger sizes, as previous to this the only teeth which afforded sufficient material for forming these front teeth crowns, in most cases, were the older forms of platinum tube molars and bicuspids. But even these older forms when shaped up to form incisor crowns, in some cases proved too small in the base (Fig. 13), while the special forms, though large enough in the base, were sometimes too short. Moreover, the disposition of the two colours of which these were formed, while suitable in all respects for

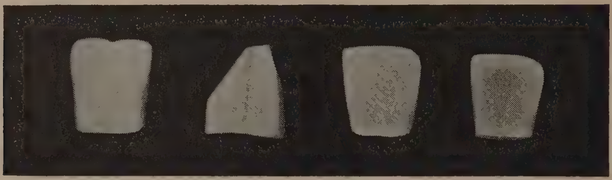
the purpose for which they were designed, precluded satisfactory results always being obtained when they were thus cut up. In consequence, the large special forms of non-platinum tubed front teeth (Figs. 7 and 8) became a necessity.

These (Fig. 7) were purposely made large enough to meet all cases, and were necessarily much too large for most, and so the smaller size of front teeth (Fig. 8) was designed with the object of still further reducing the amount of grinding necessary. These have a large enough base to cover most roots, while the larger size will easily cover any capped root. The two extra large bicuspids and the extra large molar (Figs. 14, 15 and 16) were designed for crowns requiring exceptional contour, and the bicuspids have



FIGS. 9, 10 and 11 show special forms of broad-based non-platinum bicuspid and molar tube teeth.

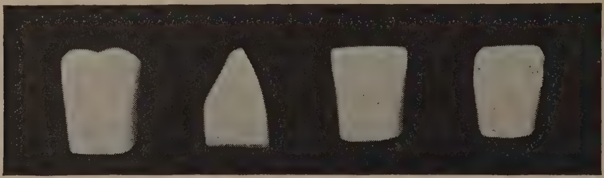
proved useful for forming centrals, laterals, large canines, etc. Fig. 17 will show how little grinding of the lingual cusps and labial surface is necessary to convert these into the largest size of



A B C D

FIG. 12. A, Special form of non-platinum tube molar. B, C, D, Stages in the formation of central crown. Note breadth of base. Time to convert the above into a central crown. 3 mins.[1]

canine, large centrals, and laterals. Moreover, the relationship with regard to the proportion of colour between the upper and the lower part of these teeth allows of extensive variation. For instance, when one of these is shaped up, if the upper half of the



A B C D

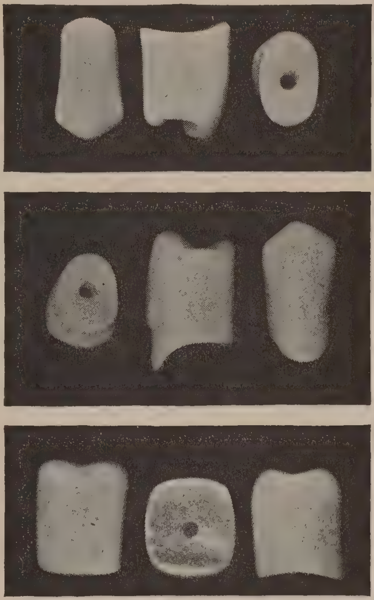
FIG. 13. A, Old form of platinum tube tooth. B, C, D, Stages in the formation of a central crown, Note base — often too small. Time taken to convert it into central crown. 3 mins.

tooth be brown in colour, while the lower half is gray, then the proportion between these can be maintained by grinding an equal length off both the cervical and incisive edges. On the other hand if the colour of the upper half of the tube tooth should require to be most in evidence, then a corresponding

[1] Unless specially mentioned smoothing and polishing is not included in the time given.

amount can be ground off the incisive edge. Or it may be that the colour of the lower half of the tooth is preferred, in which case most should be ground off the upper half. In such a case, unless the tooth required is an extra long one, this can be done.

From the foregoing, then, it will be obvious that by the system of shaping up teeth from what are practically rough forms, an extended range and an amount of freedom is obtained with regard to colour, shape, and size, which even without the addition of the non-platinum tube rods is unobtainable by any other means.



Figs. 14, 15 and 16 show extra-large non-platinum tube bicuspids and molars.

With a view to setting the reader's mind at rest with regard to what may appear a lengthy and possibly difficult means of attaining the results claimed, it may be as well to mention at once that it is proposed to deal with the shaping up and fitting of tube teeth and porcelain rods in a subsequent chapter, where it will be shown that neither as regards time nor skill is this matter of grinding so formidable as it might at first appear. Much of what one reads and hears regarding the time and labour involved in grinding teeth is no doubt due to the lack of

appreciation of the advantages now afforded by the great improvement in recent years in the materials and appliances for this purpose, as well as lack of knowledge of the means whereby these may be employed in order to obtain the best results. The reluctance which is even now shown to doing more than the minimum amount of grinding has doubtless resulted from the above, and from recollection of the days when wheels were of the poorest and the power-driven grinding lathe unknown. Under these

FIG. 17. Shows extra-large bicuspid used to form central, lateral, and canine.

Time taken to convert it into either central lateral or canine. 1½ mins.

conditions it is not surprising that the smallest amount of grinding was looked upon as a serious matter, and one to be avoided as much as possible, especially when one remembers that even the foot-driven grinding lathe was not the perfect machine it has since become. The legitimate prejudices thus engendered seem to have remained with us long after the causes which gave rise to them have been removed. Such feelings die hard, and doubtless the profession will take time to realise fully the advances which have been made. There was compensation, however, for such disadvantages as were suffered in connection with these defective appliances, in the improvement which was made in the manufacture of some of the forms of porcelain teeth and the

immense variety of these which were put at our disposal. But as the subject of grinding materials, appliances and methods is of great importance, particularly in connection with the special methods hereafter to be described, the subject will be fully considered later.

No. 4. — Non-platinum tube rods were devised primarily for use in general practice, but their value

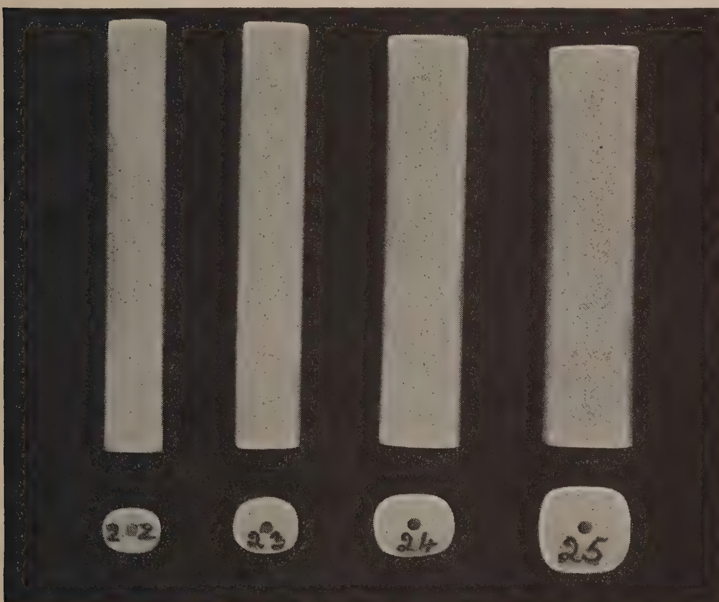


FIG. 18. Shows single tube rods side and end views.

for teaching purposes was also kept well in view, and this will be referred to later. The series consists of: —

4 Single tube rods, Nos. 22, 23, 24, and 25. (Fig. 18.)

8 Double tube rods, Nos. 26, 27, 28, 29, 30, 31, 32, and 39. (Fig. 19.)

FIG. 19

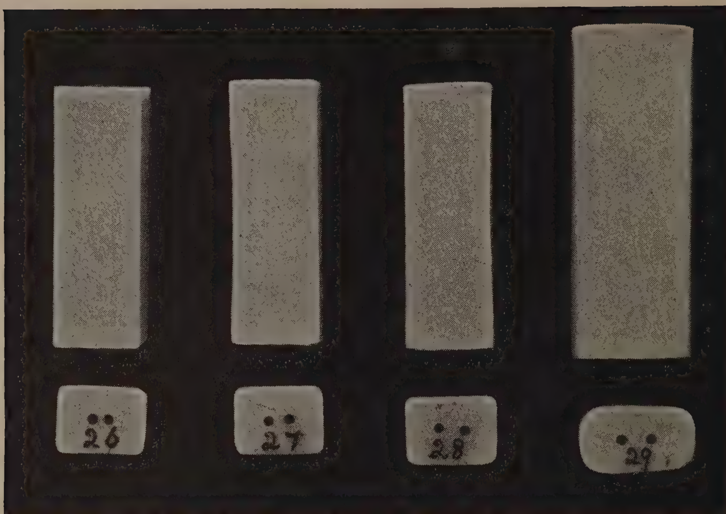


FIG. 19. A, Double-tube Rods	FIGS. 26	27	28	29
Space between the tubes	1 mm.	1-5 mm.	2-5 mm.	3 mm.

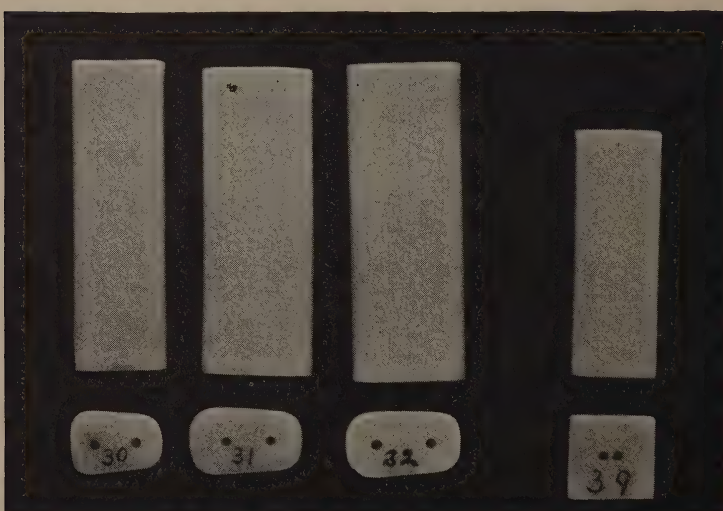


FIG. 19. B, Double-tube Rods	FIGS. 30	31	32	39
Space between the tubes	5-5 mm.	6-5 mm.	8 mm.	1 mm.

Each rod has a number stamped on it, and they may be obtained in the full range of colours, also in double colours. When the distance between the tubes is referred to, it is to be understood that the measurement in all cases is from the nearest point, not from the centre of the tubes.

From what has been already said with regard to the adaptability of the larger forms of tube teeth for conversion into the smaller varieties, and the extensive range of shades in which these are now available, it would seem that in crown work, at any rate, there is small room for the tube rod. This is, however, not the case, when it is considered that these rods supply the dentist with the blank forms from which he can shape up any tube tooth or crown to meet all cases, except those in which the bite is excessively close; while, in addition, it will be seen that they can be used for forming all porcelain bridges, gum tube sections, and for other purposes. These alone are great and obvious advantages, as the necessary materials are thereby provided in a simple and portable form, making us independent of the near proximity of a dental depot — a matter of no small importance to men who practice far from a large centre. Variations with regard to colour may be effected by employing the shaded rods previously referred to. A small selection of shades will, however, be found to meet the requirements of most cases.

It is further to be remembered that we have a choice of colouring enamels which enables us to match any shade desired, thus increasing their range of adaptability.

With regard to the size of rods, little difficulty

should be found in selecting that which will require the least amount of grinding. Generally speaking, size No. 25 will be found useful for all molars; size 24 for upper centrals, canines, and upper bicuspids; size 23 for forming upper laterals, small upper centrals, narrow upper canines, and lower bicuspids; and size 22 for lower incisors, some lower canines, and most upper laterals.

When excessive approximal contour is required, it will, of course, be necessary to employ a rod sufficiently large to afford the material. In many cases these rods are more easily and quickly shaped up to any form required than are some tube teeth. This results in part from the fact that they are more easily handled than teeth, as will be seen when the subject of fitting crowns comes to be dealt with. The double tube rods shown in Fig. 19 were devised primarily for porcelain bridge work, and it will be seen when this subject comes to be dealt with more fully that they are mostly used horizontally instead of vertically, and the following brief description is confined to those rods which are most often used in the latter way.

The number of cases where these double tube rods will be found useful grows as experience is gained with them. Probably rod No. 30, in which the tubes are 5.5 mms. apart measured from their nearest points, will be more often used than the rod No. 31, because it will be found that 5.5 mm. corresponds very closely with the distance between the centre of any single pair of average teeth, with the exception of the molars or the lower incisors. Rod No. 30 may be successfully used for forming double crowns, when these are about a normal distance

apart and of average size; also for forming — in the upper jaw, two centrals a central and lateral, a lateral and canine, a canine and bicuspid, and two bicuspids; in the lower jaw, a canine and bicuspid, two bicuspids, and a bicuspid and molar, the two last mentioned when of smallish size.

The large rod size 31, with the tubes 6.5 mm. apart measured from their nearest points, may be used in the same class of cases as those above enumerated when the teeth or crowns require to be somewhat larger and in consequence their canals somewhat wider apart.

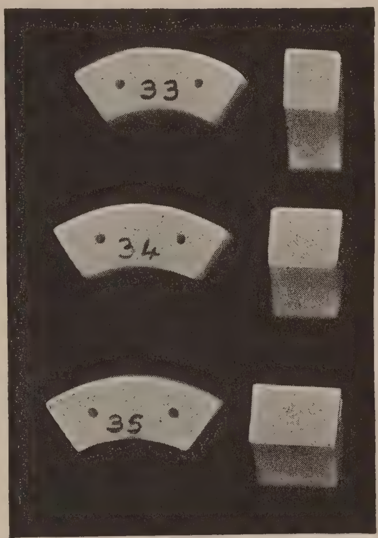


FIG. 20. Shows curved blocks Nos. 33, 34 and 35. Space between tubes 11-5 mm. End views show width of blocks.

The large rod size 32, with the tubes 8 mm. apart measured from their nearest points, may be used to form in the upper jaw two centrals, a bicuspid and canine, and two bicuspids when the roots of these are somewhat widely separated, also a bicuspid and molar, or two molars when of medium to small size; and in the lower jaw, two bicuspids when the roots are somewhat widely separated, a bicuspid and molar, and two molars when of medium size.

The large rod size 29, with the tubes 3 mm. apart measured from their nearest points, may be used for forming a cantilever molar crown with extension

arm or arms to fill a space or a molar with extension of a bicuspid either in the upper or lower jaw.

No. 5.—Special non-platinum tube curved blocks, consisting of two sets of curved blocks, three blocks in each set, known as Nos. 33, 34, and 35, and Nos. 36, 37, and 38. (Figs. 20 and 21.) Both sets are exactly similar in size and curve, and each block is 30 mm. measured along the largest arc of the circle, and they are made in three sizes —10, 12, and 15 mm. (Fig. 21 c.) The difference between the sets of blocks is that set 33, 34, and 35 have only two vertical tubes through them, and these are 11.5 mm. apart measured from their nearest points, while in the set 36, 37, and 38 there are three vertical tubes, the end ones being the same distance apart, namely 11.5 mm. and similar in size to the tube in the ordinary non-platinum tube rods. The central tube is situated exactly midway between the other two, and has a smaller calibre, about $15\frac{1}{2}$ U. S. Gauge. In addition to the vertical tubes there are two tubes which extend horizontally through the blocks from either end and meet in the centre at the point where the vertical tube intersects them, as in Fig. 21 b. These curved blocks overcome the disadvantages which sometimes arise from employing the ordinary

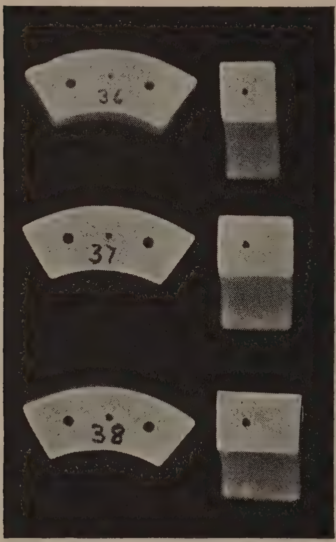


FIG. 21. A, Shows curved blocks Nos. 36, 37 and 38 a description of which is given in the text.

straight single or double tube rods, whereby the horizontal posts are apt to project either on the labial or

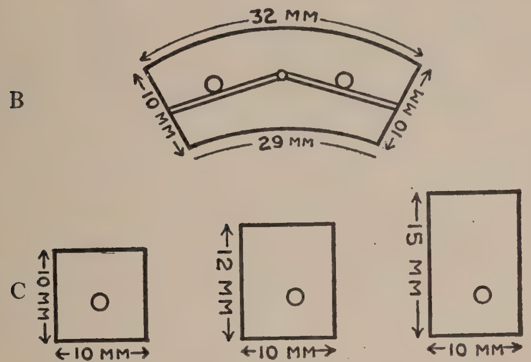


FIG. 21. B, Sketch showing plan of blocks Nos. 36, 37, and 38, with vertical and horizontal tubes. C, Shows relation of horizontal tube to lower end of block.

lingual surface, although a means is provided whereby this difficulty, should it arise, may be otherwise dealt with. They also do away with the necessity for drilling vertical tubes in certain cases where this might be necessary. They are further useful for the purpose of shaping up plain sections of two or three teeth, gum block sections, and for many other purposes. (Fig. 22.) By the use of these sections, any desired curve of arch from the largest to the smallest can be obtained (Fig. 23), while sufficient material is available to permit of any form of irregularity being reproduced. With regard to the tubes, experience has

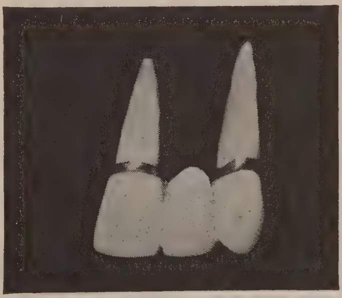


FIG. 22. Shows bridge of 3 teeth shaped up from tube block No. 34.

shown that the distance between the centre of the canals of the canine and central incisor of either side of the upper jaw is about 11.5 mm. irrespective of the width of the crowns of the teeth; but should the canals be wider apart, or closer together, the porcelain tubes may be reamed out in the direction required, or one or both posts may be re-soldered to the cap in the manner to be described later.

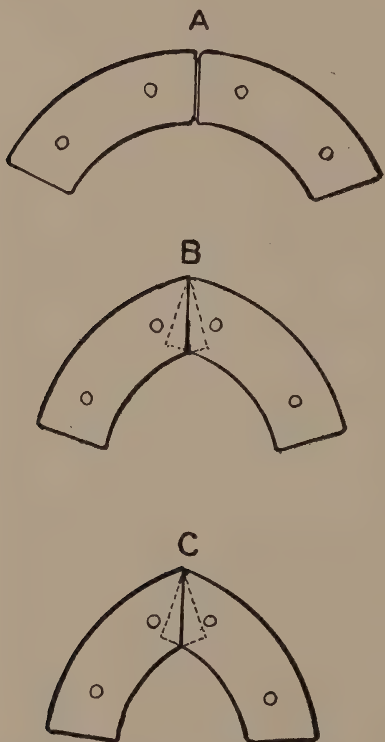


FIG. 23. Shows how curved blocks can be adapted to any size of arch.

The object of the central tube is to provide for a post in a lateral incisor and in other cases where this may be necessary, but as it is likely to be less frequently required than the other two, a smaller tube only is provided, and this can be enlarged if need be by means of a diamond reamer, and a special set of these reamers with extra long shanks is provided suitable for reaming out and enlarging the tube of tube rods as shown in Fig. 24.

Lastly; with regard to the horizontal tubes. These are for the purpose of providing additional strength and anchorage, and these horizontal tubes in blocks

Nos. 36, 37, and 38 are all situated 4 mm. from the bottom edge, as in Fig. 21 c; and the purpose for which this is intended is to provide for the tube being so situated with regard to its relation to the teeth and gum portion, or to the crown when crowns only are used, that the horizontal post need not be exposed during the shaping up process.

Where either a vertical or horizontal tube is not required, it can readily be filled by means of a section of post cemented into it, and this is described in chapter XVI.

There are many other possible applications of these straight rods and curved blocks, and in connection with the illustrations of these which are to follow, the number of the rod used will be given.

Fig. 24. Shows special forms of diamond reamers, (Ash & Sons, Ltd. London).

In conclusion, therefore, the materials at present available for tube work, along with the special purposes for which they are likely to prove most frequently useful, may be summarised as follows. It is to be noted, however, that the writer is well aware that a few more tube blocks for use in porcelain plate and bridge work might advantageously be added, and doubtless will be. At the same time, there are very few cases met with in practice which cannot be successfully dealt with by means of the materials described, and this will be apparent from the numerous examples given later.

(A). Old style platinum incisor and canine tube teeth still manufactured, also now made without

platinum tubes. Seldom broad enough in the base to cover a cap or root. Useful for plate and vulcanite work also in connection with the casting process, but too narrow in the base when teeth have to be set on the gum.

(B.) Old style platinum tube bicuspids and molars, also now made without platinum tubes. Most of the bicuspids are too small in the base to cover the surface of upper bicuspid roots. Suitable for crowning lower bicuspids, incisors, and canines, and for forming upper laterals. The molars are too small in the base for forming crowns, but are useful for forming upper and lower incisor, canine, and bicuspid crowns. Both the bicuspids and molars are valuable for use in plate, vulcanite, and in connection with the casting process.

(C). Special forms of non-platinum tube bicuspid and molar crowns in a full range of shades.

Incisors — 2 sizes
Bicuspids — 3 sizes in five lengths
Molars — 3 sizes in four lengths

These are large enough in the base for the purpose of forming all teeth and crowns.

(D). Single tube non-platinum tube rods in four sizes, Nos. 22, 23, 24, and 25. The smallest size, No. 22, will be found useful for forming lower incisors, some lower canines, and most upper laterals. No. 23 for forming upper laterals, small upper centrals, narrow upper canines, and lower bicuspids. No. 24 for forming upper centrals, canines, and upper bicuspids, also in bridge work. No. 25 for forming all molars, large centrals, and in bridge work.

(E). Double tube rods and tube blocks. There are eight double tube rods, also two sets of tube

blocks, but it is needless to enumerate the various uses to which they may be put. Suffice it to say that they may be used for single and multiple crowns, also for bridge, plate, and vulcanite work, and in connection with the casting process, and illustrations will be given of all of these.

(F). Single gum tube teeth and gum tube teeth sections similar to the old forms are suggested for use in plate work and especially in connection with the casting process.

Attention is once more called to the deficiency with regard to the basal area of nearly all of the forms of tube teeth, with the exception of those special kinds devised by the writer. Doubtless new shapes and sizes would much diminish the amount of grinding and shaping up necessary in many cases, and would tend to popularise the tube tooth with those who object to all but the minimum amount of work. It is to be hoped that makers will be stimulated by these suggestions to offer us some half-dozen, or even a dozen, sets of upper front tube teeth, also a few sets of lower front teeth in the full range of shades, and designed on the lines of the short-bite tooth, taking great care to have sufficient basal area of porcelain so that they may be used in crown work. Such a selection would suit a large number of cases with but a small amount of shaping up, or possibly none at all; while most of the narrow-based front tube teeth would be useful for plate and vulcanite work.

CHAPTER III

POSTS AND TUBES AND SOME REMARKS ON THE CASTING PROCESS

WITH respect to the metals employed little need be said here except in connection with the posts and tubes, regarding the application of which details will be given in subsequent chapters. These may be of gold, dental alloy, or iridio-platinum, and in certain cases of one of the base metal alloys. When the posts are of gold, which is recommended for most cases, an alloy should be used which yields a wire of sufficient stiffness and toughness, and which is at the same time of high enough carat to permit of its being soldered with high grade solder. A suitable alloy is coin gold 20 dwt., pure platinum 10 grs. (Essig). The wire for posts should be made into straight lengths, is usually supplied by the dealers, and should be about 15 U. S. Gauge,[1] or say .056 of an inch, and for non-platinum tube teeth and porcelain rods the wire should be about 13½ U. S. Gauge, or say .068 of an inch, as these fit accurately but not too tightly into the respective tubes.

Dental alloy. This is an alloy of platinum and silver introduced in 1862. Its composition varies somewhat in accordance with the ideas of the makers. It is usually supplied in two qualities, No. 1

[1] Unless otherwise specially mentioned, Brown & Sharp's Standard American Gauge plate is the one referred to in connection with the size of posts, tubes, bars, and plates, and so the term U. S. G. will be employed.

containing two parts of silver to one of platinum, and No. 2 containing three parts of silver to one of platinum. More than $33\frac{1}{3}$ per cent of platinum would not yield a workable alloy. No. 1 melts at 2150° Fahr., and the latter at a lower temperature, but both may be soldered with any grade of solder up to pure gold, although care is necessary when the latter is employed, as the silver is liable to be burned out, and the alloy in consequence rendered brittle; this may also take place as the result of several solderings. Its working properties are very similar to those of 16-carat gold, and its liability to tarnish is about the same. The colour is nearer that of platinum than of silver.

Iridio-platinum. The properties of this alloy are too well-known to call for any special remarks. Its use is seldom called for in tube work.

Base metal alloys. Certain base metal alloys may be used for the purpose of forming horizontal anchorage and strengthening bars for tube bridges, plates, etc. The most suitable are certain of the alloys of German silver, which are vended under various names, such as "White Metal Alloy," etc., and some of these are remarkably tough and strong and permit of being soldered with the highest grade of solder as well as with pure gold, giving as perfect a union as can be obtained between gold and a suitable gold solder. Certain of these base metal alloys are, however, worthless, but most dealers will undertake to supply a reliable one.

Split Posts. As split instead of solid posts are frequently used in connection with porcelain tube work, a few remarks regarding the making and soldering of these may be useful. Half-round wire

is made in the same way as round wire, but instead of a draw-plate with round holes in it, one with half-round holes is used. But half-round wire may be produced by the aid of a round hole draw-plate. To do so take a piece of round wire and flatten it slightly by filing, hammering, or passing it through the flatting mills. Next fold the flattened wire in half and solder the two ends together for a little distance. Make a point on the soldered end, and draw the wire through the round holes in the usual way, taking care that they are kept true, which may be done by holding the blade of a knife between the two halves of the wire close up to the draw-plate, while the wire is being pulled through it.

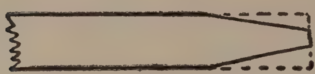
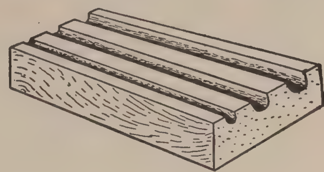


Fig. 25. Putting point on strip of metal for tubing.

In order to prevent split posts from being soldered together, insert a piece of thin stiff writing paper between the two halves of the wire.

Metal tubes. As tube posts instead of solid posts will be frequently referred to, a short description of how to make them is herewith given. The metal employed will usually be gold, and the thickness of metal employed will depend upon the stoutness of the tube desired. For the purpose of forming a tube of the proper size to fit the tube of a non-platinum tube tooth or porcelain rod, a strip of gold about 5 mm. wide should be marked off by means of dividers from a sheet of the metal about 36 U. S. Gauge. Having seen that the edges of the metal strip are parallel, a point should be made at one end by cutting a small piece off each side of the strip (Fig. 25) which should next be annealed. Then with a piece of hard wood, or a

piece of metal in which there are a number of semi-circular grooves, the edges of which in the latter have been rounded off (Fig. 26), tap the strip into one of the grooves with the narrow end of a hammer (Fig. 27), commencing near the edge. The hammering should be continued till the tube is fairly round and the edges almost closed. The latter are then scraped with a three-sided scraper to insure their being perfectly clean, the annealing having put on a fire skin. Another method is to place the strip of gold lengthwise along the groove in the block, and with a steel rod slightly smaller than the width of the groove, drive the metal strip and mandrel into it, following this up as already described, until the edges are almost closed (Fig. 28).



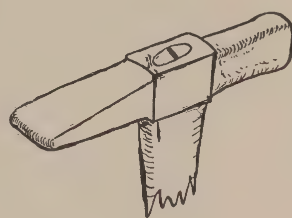


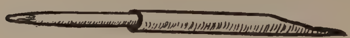
FIG. 26. Grooved wood block on which strip is hammered up.

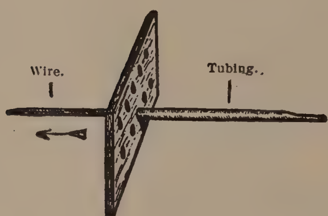
FIG. 27. Hammer used for tube-making.

FIG. 28. Stages of hammering up strip to form tube.

The tubing is then taken to the draw bench, and drawn through a plate until the edges are quite closed and the tubing perfectly round. This is very important, as if the tubing be soldered before it is quite round, there will always be a "kink" in the bore at the joint. In order that one may be quite certain that the inside of the tube is quite true, a piece of wire may be introduced before passing the

tubing through the draw-plate for the first time. This wire should be of copper, not steel, as the latter metal does not yield to compression, and consequently the tubing might be thinned at certain places during the drawing process. The wire, as well as the inside of the tube, should first be waxed or oiled to facilitate the withdrawal of the wire. File a point on the wire and in placing it within the tube leave the point on the wire projecting from the distal end of the tube (Fig. 29). After the tubing has been drawn to the proper size, push the point of the wire through a hole in the draw-plate, which will allow it, but not the tubing, to come through. The wire may now be easily withdrawn (Fig. 30). Having got the tube round tie it with binding wire using small pieces at short distances apart (Fig. 31). Then apply a thick solution of borax on the outside of the joint and introduce some of it into the bore of the tube, working it along the whole length of the joint with a fine wire. This ensures the joint being properly soldered, the borax inside drawing the solder through. Now, cut tiny pieces of 20-carat solder, and carefully lay them along the joint. It is very important that too much solder should not be used, but, of course, no definite





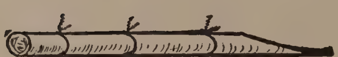
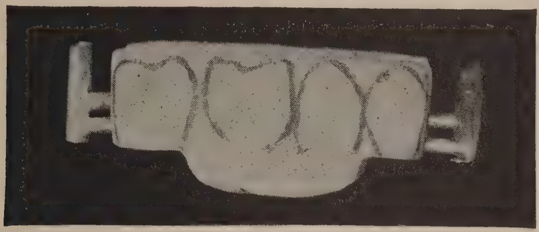


Fig. 29. Shows how copper wire is introduced into tube. Point of wire sticking out.

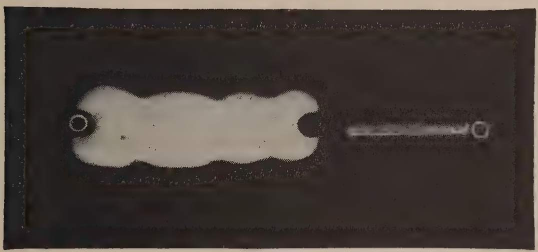
Fig. 30. Shows how copper wire is withdrawn from tubing by means of draw-plate.

Fig. 31. Method of tying tubing.

rule can be given for the amount required; this must be left to the judgment of the operator. Dry the borax very carefully with the blowpipe flame so as not to make the solder jump, and then starting at one end heat gradually and flow from one end to the other. If this operation is carried out carefully, the



A



B

FIG. 32. A, Shows length of tube rod No. 27 with teeth outlined for bridge and showing tubed inlays joined to horizontal bars. B, Coronal view, showing vertical groove for tubed inlays.

joint will be completely closed, the solder having run well between, and on account of the minimum of solder being used, no obstuction is made in the bore of the tube. To finish, use file and fine emery-paper.

Exactly the same method should be employed in making tubes of German silver, brass, or copper, except that the joints of these need not necessarily be soldered, though it is best that they should be. These base metal tubes are useful for temporary

crowns, and for other purposes. It is also an advantage to have on hand a series of precious metal as well as base metal tubes. The special purposes for which these will be useful will be seen later.

The addition of a Metal Lining to a Porcelain Tube

While it was pointed out that no special advantage is obtained by the use of a platinum tube in a tube tooth, there are certain cases in which a metal lining is necessary, or at least advisable, and this also

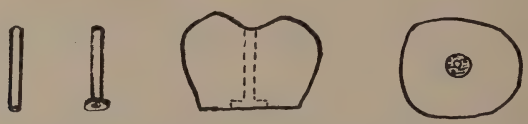


FIG. 33. Method of lining porcelain tube. A, Single length of tubing. B, Washer soldered on. C, Tube and washer in place. D, Basal view.

applies to removable bridges where split posts are employed, but only where tubed inlays cannot be used in the manner shown in Fig. 32. The porcelain tube generally requires to be enlarged by means of a diamond reamer, and its diameter will depend upon the size of the split post which it has been decided will best meet the requirements of the case. A good average for a molar anchorage is about No. 11 U. S. G. for the metal tube and about No. 12 U. S. G. for the split post, but the size of posts and tubes must be governed by the size of tooth and the amount of strain to which they are likely to be subjected. The point of chief importance in this, as well as in all other cases where tubes and posts are employed, is to note that the post fits the tube easily but accurately. The following method will

be found to give satisfactory results: — Cut off a length of very thin tubing (Fig. 33), then form a washer or disc of gold from a piece of plate about 20–24 Gauge, and solder it to the base of the tube. Having formed a recess in the base of the porcelain into which the gold disc fits, the united tube and washer should be cemented to place, or pure gold may be burnished into the recess in the porcelain and the solder attaching the tube to the washer permitted to fill up the latter.

The Casting Process

Before proceeding to deal with the subject of the superiority of tube teeth over other forms, it may be well to point out that little will be said with regard to the casting process, and the omission will not be due to lack of appreciation of its advantages or admiration of its authors, Dr Taggart of Chicago, and Dr Solbrig of Paris, as well as of others who by their untiring efforts have brought it to such perfection. These workers have earned the gratitude of the profession for all time. It is seldom, however, that a new system is brought forward which in every particular proves superior to the one which it is designed to supersede, and the casting process is no exception. It fails to afford sufficient opportunity for acquiring and developing that skill in metal working which distinguishes craftsmen, and the development of which the introduction of vulcanite did so much to check. No one, however, would dream of suggesting that the casting process should be discarded on account of the over-enthusiasm of some who employ it injudiciously, and who would

have us believe that it may with advantage be made to supersede all other methods. Possibly it could be, but we should still be the losers, for the reason already given. To the present generation of practitioners this would matter little, as their methods of working are more or less fixed; besides they have the choice of methods. But with the rising generation of students there is danger of too much dependence being placed on the casting process, and as these papers have been written partly with the object of directing attention to the necessity for developing the student's artistic skill as well as his manual dexterity, the advice is tendered to those in authority to exercise care that such a valuable system as the casting process is not allowed to interfere with the methods of training which have hitherto served us well; and that while the process should be thoroughly taught, it should not be given first place, but treated as a valuable adjunct, and the older constructional methods mainly relied upon.

The following pages will afford ample evidence that the writer fully realises the great value and importance of the casting process.

CHAPTER IV

SUPERIORITY OF THE TUBE TOOTH

THE tube tooth differs from the plain tooth [1] in one notable essential, viz: that its attachment is effected by means of a central tube into which a post or pin is introduced. A few of the advantages claimed for it are as follows: —

The tube tooth can be used for all classes of work — crowns, bridges, and plates, either of gold or vulcanite.

It is adaptable in any situation on both jaws, and is much stronger than any other form of tooth. Being supported over its whole surface, the greatest strain in occlusion falls mostly in a vertical direction upon the crown, whereas in a plain tooth the impact of the bite is less evenly distributed.

Its range of adaptability is much greater than that of any other tooth and so a small stock goes a long way. A tube tooth, however large, and of whatever type, provided there is enough bulk of porcelain and it be of suitable shade, can be ground and shaped to any desired form, and the porcelain being of the same texture throughout, it can be polished perfectly. Moreover, a tube tooth misfitted can generally be used again for another case.

[1] The term "plain teeth" is used in American Catalogues to denote teeth with platinum pins either for plate or vulcanite work, exclusive, of course, of gum sections which also have platinum pins; whereas in the Catalogues of English manufacturers the teeth for plate work (plate work means metal plate, usually gold) are called "plate or flat teeth" while those for use with vulcanite or other plastic base are known as "vulcanite teeth."

For crown work, tube teeth have all the advantages already enumerated, and in addition can be more perfectly and directly fitted to the root than any other form of porcelain crown. When mounted they retain unimpaired their translucence, a quality so often destroyed by a metal backing. Their most marked superiority over all other forms of all-porcelain crowns is their almost limitless application.[1] In addition to these claims, the following facts deserve attention: — It is probable that owing to their closeness of texture English teeth are stronger than moulded teeth (see "American Text-book of Prosthetic Dentistry," by C. J. Essig, ed. 1897, p. 265), and it is claimed by the makers that tube teeth are stronger than pin teeth. Tube teeth, which are poured teeth, are made at one baking in the furnace, the body and glaze being combined, and thus these teeth differ from moulded teeth in which the body is biscuited or baked, and the glaze or enamel added and afterwards fired. While the former method results in a porcelain of undoubtedly greater strength and closer texture, which, after grinding enables it to be completely restored to its original condition by polishing, it is at the same time slightly less translucent; but the difference between these teeth is now less marked than formerly, owing to modification with regard to the composition and manufacturing of moulded teeth.

Being a more faithful reproduction of the natural tooth, it feels more comfortable to the tongue. Moreover, it renders articulation more easy and

[1] These claims on behalf of the tube tooth were brought forward by the author in a paper read before the "World's Columbian Dental Congress" in 1893. Time and experience have served to show that these were under, rather than overstated.

distinct and prevents detection when the mouth is opened.

It is more easily kept clean, because backings are done away with, better supports being substituted which, being surrounded by porcelain, are out of reach of any impurity.

In plate work its use entirely removes the danger of warping in soldering which sometimes happens in fixing flat teeth to a gold plate.

Having thus stated in a general way the advantages which tube teeth possess over other forms, it is proposed to consider in greater detail the special advantages of their use, particularly in crown work; and this will serve to direct attention to some of the weaknesses inherent in other types.

Adaptability is doubtless the outstanding feature of the tube tooth in whatever class of work it is employed, but its superiority is probably more marked when used in crown work than in any other branch of dental work. It has been already stated that there is practically no limit to the size of tooth which may be used, and that the non-platinum tube rod is indeed as suitable as the tube tooth; and the only limit is in the case of an abnormally close bite. Moreover tube teeth lend themselves more readily than any other type of tooth to the perfect restoration of occlusal surfaces; a point long neglected, but which of late years has commanded much attention. These qualities alone make the tube tooth unique among porcelain teeth.

Another advantage is with regard to the position of the post in relation to the crown, which can be varied more than in any other form of detached-post crown, owing to the fact that any or all of its surfaces

may be ground in any direction, and afterwards polished so that it can have a surface like new. It is not necessary, therefore, though it is generally advisable, to have the post in the centre of the tooth.

FIG. 34. Section through tooth root, showing solid post in central canal.

Such variations as are obtained in this way could be still further extended by bending the post (Fig. 34) or by reaming out the canal; but this latter is unnecessary in the case of tube teeth, though often required when other forms of crowns are employed.

Thus it will be seen that the variations obtainable with regard to the crown in its relation to the post are greater than with any other form of crown. In certain cases, — such as, for instance, in a molar, — the post carrying the crown need not be continuous with that which enters the root or roots (Fig. 35). Again, in the case of an upper first bicuspid when from any cause only one canal, say the lingual, is available, and a straight post is used, a tooth sufficiently large to cover the buccal aspect of the root and project well on the lingual surface may be selected and ground to fit root and bite. The

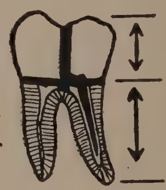


FIG. 35. Section through lower molar, to show use of separate pin to carry porcelain crown.

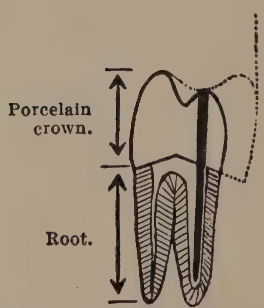


FIG. 36. Section through double-rooted tooth with porcelain crown having dowel and post in one straight line and in lingual canal. Dotted line shows original size of tube tooth used for crown.

projecting lingual portion may then be ground off, leaving the crown, with the pin, nearer the lingual aspect (Fig. 36). When both canals can be utilised, separate posts may be placed in each, and these joined together by means of a central post to carry the crown (Fig. 37). In the case of a front tooth, the post may be inclined toward the cutting edge of the tooth, the face of which can be ground away so as to have the maximum amount of porcelain available on the lingual surface, where the greatest amount of strength is needed (Fig. 38); or that part of the post which carries the crown may be cut off and readjusted (Fig. 39).

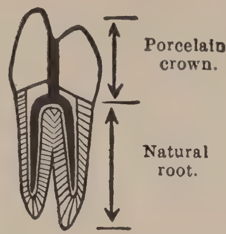


FIG. 37. Section through double-rooted tooth with porcelain crown mounted on solid post.

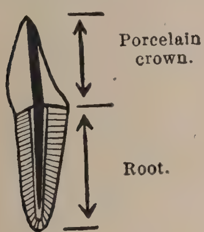


FIG. 38. Section through single-rooted tooth with porcelain crown, to show position of solid post.

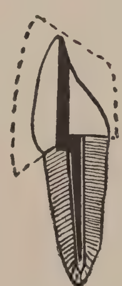


FIG. 39. Showing how a large piece may be cut off the face of the tooth, and the pin placed labially, in order to give maximum strength lingually.

Thus the variations which can be effected are extensive, and can be adapted with a view to conserving the greatest available amount of strength in the porcelain, and at the same time obtaining the maximum amount of strength for the post. Numerous opportunities for varying the application of these methods will suggest themselves, and be met with in practice.

It has been seen from the reasons already given

that the tube tooth has a greater range of adaptability with regard to the relation of post and crown than any other form; but sufficient prominence has not been given to the part taken by the tube and post in assisting accurate fitting of the crown. In the first place, the tube itself, as already seen, passes through the centre of the tooth, which may thus be of any length provided that it is long enough. It can thus be fitted to the cap or root without fear of becoming too short in the process of letting down, and when let down attention can be directed either to grinding off the surplus to suit the bite, or, if the tooth be excessively long to begin with, the surplus can be cut off in a way hereafter to be described. In consequence of this its adaptability is still further enhanced, while in addition the post, which should fit the tube accurately, but easily, acts as a sure guide in letting down the tooth to the base. The importance of this never seems to have been realised in any other type of crown, otherwise provision would undoubtedly have been made to meet it. Indeed, attention does not appear to have been called to it in crown work, though the value of the pin as a guide to accurate fitting of tube teeth in plate work has always been fully realised — so much so, indeed, that the easy but accurate fit of pin to tube has been looked upon as a matter of the utmost importance by the tube-worker, a too loose fit of pin to tube being known from experience to result in loss of time in attempting to secure accuracy of fit, as well as diminishing the security of the anchorage of the crown to the post. It is obvious, therefore, that what holds good with regard to fitting a tube tooth to a plate must of necessity apply in fitting a tube crown to a

cap, or directly to a root. It is of importance, therefore, to employ the standard size of posts or pins, except in such exceptional cases as will be dealt with later, and to reject any teeth of which the tubes do not conform to the sizes given.

It has been claimed that the mode of attachment of the tube tooth to its base is far stronger than that of any form of plain tooth or removable facing, or indeed of any other form of crown. This is largely contributed to by the possibility of altering the position of the post and tube in their relation to the body of the tooth, so that, by grinding, the maximum amount of strength of porcelain can be left where it is most needed (Fig. 40). It may further be noted that if the lingual surface of the tooth body be ground through from top to bottom, exposing the pin on the lingual surface in its whole length — as, for instance, in the case of a front tooth — the attachment is still a fairly strong one, as will be seen from the accompanying illustrations (Figs. 41 and 42). Under such abnormal conditions the porcelain face would have at least as secure an attachment, indeed a stronger one, than a plain tooth unprotected by backing at the cutting edge, which in certain circumstances is unavoidable, because the porcelain would be supported from tip to base by, say, three-quarters of the diameter of the post. It is not, however, suggested that it would be

FIG. 40. Shows best position for tube.

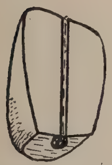


FIG. 41. Showing back of tooth cut away, exposing tube in its full length.

FIG. 42. Cross section of same.

advisable to depend entirely on such an attachment, but the strength of the attachment in comparison with a pin tooth will be sufficiently obvious.

With regard to the back teeth, their strength is even more marked, because the greatest strain in occlusion falls mostly in a vertical direction, and so is more evenly distributed. As a consequence, these teeth can be ground to an apparently dangerous thinness.

Fig. 43.

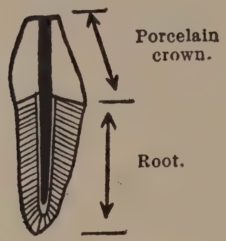


Fig. 43. Shows position of pin in edge-to-edge bite.

In the case of an edge-to-edge bite, this property is of the greatest value, and, taken in conjunction with others, pre-eminently renders the tube tooth suitable for use in such cases (Figs. 43 and 44).

The important part taken by the tube in the older forms of crown, those in which the tube or hollow perforation passed through the crown, such as the Foster, the Gates-Bonwill, or the How dovetail crown — calls for further consideration. The points which were believed to be of greatest consequence and to which most attention was paid, were the anchorage of the crown to the post, limitation of the amount of grinding of the crown to the base, and a fairly large amount of lateral movement, having the post as a centre, also with a view to the smallest amount of bending or mutilation of the latter (see Fig. 4, Chap. I).

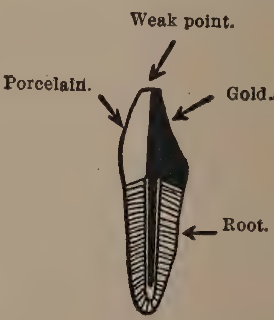


Fig. 44. Shows weak point in Richmond or other porcelain-face crowns.

With regard to the question of anchorage, experience has proved that not only was the attempt to gain extensive anchorage of the crown to post by means of an abnormally large tube a mistake in itself, resulting in much weakening of the crown by diminishing the amount of porcelain and substituting in its place (Figs. 45 and 46) a mass of superfluous anchorage material, but that the maximum amount of attachment of crown to post can be had with a very thin layer of cement, and rotation of the crown on the post, so much feared, is never met with if ordinary care has been used in cementing the crown to place. Moreover, experience has proved that it is practically impossible to separate crown from post when they have been so united. If further proof were necessary to show that the smaller the amount of cementing material used the greater the strength of anchorage resulting, it is afforded by the various inlay operations where endeavour is made to have such accuracy of fit as shall insure the use of the smallest possible amount of anchorage material. At the same time, an excess of anchorage material does not necessarily imply insufficient security of attachment. It will be seen later when the subject of

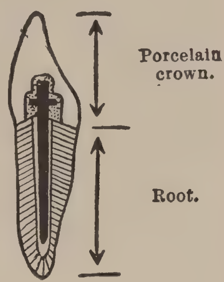


FIG. 45. Section through single-rooted tooth, showing mode of attachment of Davis crown. Dotted portion is cement.

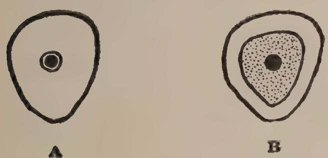


FIG. 46. White portion porcelain; dotted portion, cement.
A, cross section through bore of tube crown, showing small quantity of cement required. B, cross section through bore of ordinary porcelain crown, showing large quantity of cement required.

crown work comes to be dealt with, that the ordinary tube tooth lends itself readily to forms of attachment other than the usual basal one as in Fig. 47, while many other forms of anchorage are practicable when tube teeth or crowns from tube rods are used.

1 2 3 4 5

FIG. 47. Stages in shaping up a central incisor from double-tube rod. 1, Section cut from block; time, 3 min. 2, Rough shaping up; time, 6 min. 3, A further stage; time, 3 min. 4, Shaping up completed; time, 18 min. 5, Side view. (To this would have to be added 10 min. for smoothing and polishing. Total time, say, 30 min.)

In fact, anchorage may be obtained from any surface desired. The provision made for longitudinal adjustment, by having the post pass right through the body of the crown, while excellent in itself, had its value lessened by the defects already mentioned in

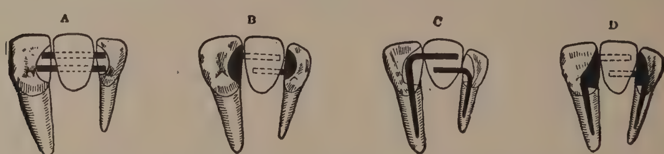


FIG. 47. Various forms of attachment as described in text.

the crowns themselves. In consequence there was always the fear that if much porcelain had to be ground off the base of the crown, anchorage of crown to post would be sacrificed. The result of this attempt to obtain the maximum amount of anchorage combined with a fair range of lateral adjustment, was a series of crown types deficient in amount of

porcelain, hence in strength, and with the further disadvantage of limitation with regard to adaptability. The provision for lateral adjustment was limited in amount, and little could be obtained except at the expense of still further weakening an already weak crown.

The reasons advanced for the failure of these earlier types of crowns to meet the requirements of

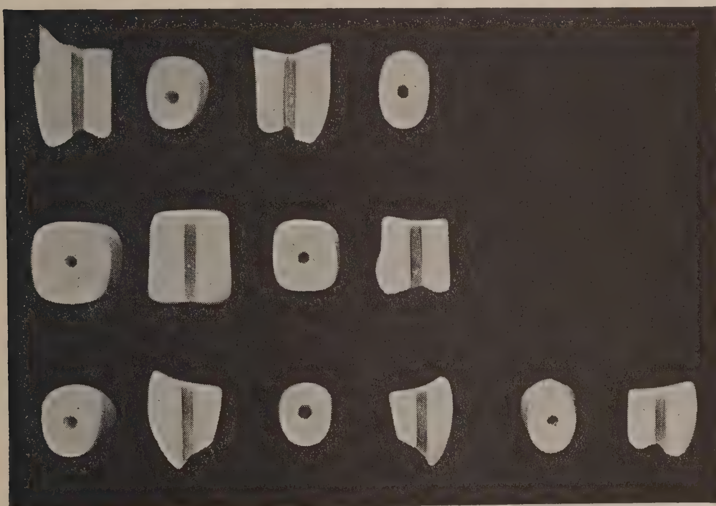


FIG. 48. Base and longitudinal sections of some forms of non-platinum tube teeth, showing strength of porcelain.

adaptability and strength apply with equal force to the present forms of detached-post and fixed-post crowns, in which the range of longitudinal adjustment is still further limited owing to the post only passing about half-way through the crown. In consequence of this, their use demands an unnecessarily large selection of forms and sizes, and frequently an excessive sacrifice of root surface. With the tube tooth, on the contrary, all these objections

are done away with, and the number of forms reduced to a minimum; indeed, it has been shown that even tooth forms are unnecessary, but that porcelain blocks or rods with a central tube formed in them can, if required, be utilised for all purposes. Objection may be taken to the tube passing entirely through the body of the crown, and being thereby a possible source of weakness, but this is negatived by long experience. Fig. 48, which shows sectional views of the special forms of non-platinum tube teeth, affords proof to the contrary.

With regard to the tube rods mentioned in the previous chapter, it will be noted that these further extend the application of the principle of the tube attachment, and increase the area of their adaptability.

There remains another point which calls for consideration here, namely, the reluctance always shown to grinding any part of the body of the tooth other than the base and occlusal surface. This has doubtless arisen from the difficulty experienced in satisfactorily polishing the ground surface of moulded teeth, as these cannot be got to look so well after the surface glaze has been removed. This objection does not hold good with poured teeth, which, as already stated, and will be shown later, can be given as perfect a polish as when new. At the same time, the ordinary methods of polishing even poured teeth are crude and unsatisfactory, and the results obtained are so disappointing that it is not surprising that every effort has been directed to avoiding this. This difficulty to which expression is seldom given, and which no doubt is seldom realised, doubtless accounts to a large extent for

that dread of interfering with those surfaces of the teeth which would demand repolishing. The enormous and constantly increasing selection of new forms of teeth and crowns has probably resulted mainly from this cause, though the defective materials and appliances for grinding and polishing have also helped.

Mention has been made of the suitability of the tube tooth for conversion into that of any other type of detached tooth crown. Herein it differs from all other existing types, which lend themselves only to that form of attachment for which they were designed. The reason for this will be obvious when one remembers that the tube tooth or porcelain rod has a simple tube which passes through the body of the tooth, and that there is no further weakening of the porcelain such as is met with in other crowns (Figs. 49 and 50). Further, owing to the fact that any size of tooth can be employed, abundance of material is provided whereby any desired form of crown can be reproduced to conform with that of any existing type. This brings within our reach a simple means of replacement in case of accident, for, as the forms of detachable crowns are now so numerous, one cannot rely on obtaining a duplicate crown at a Dental Depot. Even if one adheres to one form only, a fairly large stock is called for to meet average requirements. The chances, then, of a patient who may want a crown

Fig. 49. Longitudinal section through tube crown, showing central tube running right through.

Fig. 50. Longitudinal section through ordinary form of porcelain crown.

replaced having had the same type of tooth we are in the habit of using, are not great.

The tube of the tube tooth or rod can, however, be quickly ground to the form of the basal anchorage of that of any type of crown. At all events, it can be adapted to a form of anchorage which will enable it to conform to the proximal end of any post or dowel by means of suitably shaped Butler's carborundum points and diamond points, meanwhile retaining those other advantages which it has been shown to possess. (Figs. 51 and 52.)

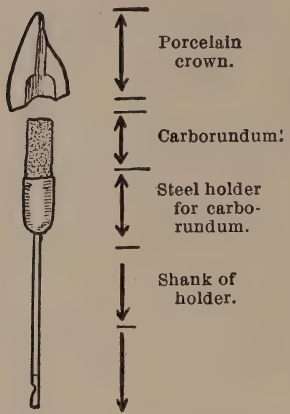


FIG. 51. Method of converting tube crown into one of the ordinary type.

Comparison having been made between the tube tooth, porcelain rods and various forms of detached-post crowns, and some of the disadvantages of the latter pointed out, it remains to be considered whether the fixed-post crown is free from any or all of the latter.

FIG. 52. Shows how to adapt a bicuspid tube tooth to the anchorage provided for another form of crown.

Taking the Logan crown as typical of the best form of fixed-post crown, it will be seen from Fig. 53 that its range of radial adjustment is limited by the difficulty of bending the post to a sharp enough angle close to the point of junction between post and crown, when bending is called for, and that further adjustment can be obtained only

by enlarging the canal, with consequent weakening of the root. Furthermore, alteration of the base of the crown in relation to the root surface must be had either by grinding off from the labio-cervical or approximal surface or surfaces, or from both, or else by removing a corresponding amount from the surface of the root. These defects alone have proved of sufficient importance to diminish the popularity of the fixed-in favour of the detached-post crown, while both fall short of the tube crown with regard to the points of adaptability already mentioned.

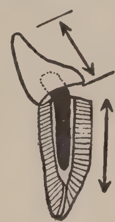


FIG. 53. Section through single-rooted tooth, to show difficulty which is sometimes encountered when adjusting a Logan crown.

Another advantage in the use of tube teeth, which is shared with the various forms of detached tooth crowns, is that the necessity for soldering is done away with, as well as the danger of fracture or discolouration.

In plate work these advantages are also apparent, while in addition the dangers which arise from warpage in soldering are eliminated. Moreover, the diminution in the amount of solder is a further substantial gain, as the liability to discolouration is lessened, and the carat of the piece is maintained at a higher standard.

There remains yet another point with regard to the use of tube teeth which is shared by other forms of all-porcelain crowns, and to which special attention is drawn, namely, the advantage which these possess over plain teeth in presenting a natural convexity of outline in their approximal surfaces. This is of particular value where there is spacing,

even if it should be slight, and prevents that flattened appearance and dark shadow produced by a metal backing. The advantage with regard to tube teeth in this connection is as apparent when they are employed in bridge, plate, or vulcanite work as when they are used for crowning only.

Approximal contact. The matter of approximal contact where normal conditions prevail can be successfully carried out by means of the ordinary all-porcelain crown in general use. Cases occur, however, in connection with the grinding teeth in which the space is too large to admit of approximal contact being obtained by the substitution of a single porcelain crown, and yet too small to allow of the satisfactory insertion of two crowns. In these cases resort has been had either to an all-gold crown with exaggerated approximal contour to obtain contact, or a porcelain-face crown, or a built-up porcelain crown treated in the same manner; but on referring to the chapter on tube teeth and porcelain rods, it will be seen that these are pre-eminently adapted to meet the above class of cases, and in a manner not hitherto suggested (Fig. 54).

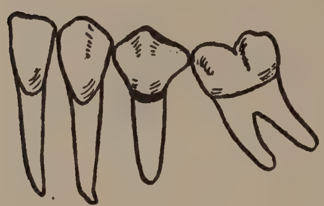


FIG. 54. Shows excessive contour on first bicuspid tube crown to fill up space, due to loss of second bicuspid.

Much that has been said in dealing with the special advantages which tube teeth and non-platinum tube rods possess in crown work, applies also to their use in plate, vulcanite, and bridge work, in all of which they can be relied upon to yield even better results than would appear from the claims which have been

advanced in their favour and which, so far, have been directed to the mechanical rather than the artistic aspect of this question. As previously stated the most powerful argument against the moulded tooth so largely used is the fact that it does not lend itself so readily to satisfactory polishing after its surface has been broken as does the poured tooth, though the line of demarcation between the poured and moulded tooth is less marked than formerly. There seems little doubt that this has been the main factor in deterring men from grinding these surfaces which lend themselves so freely to alteration of type.

Superiority of the Tube Tooth over Fused Porcelain Crowns

During the last twenty years, and particularly within the last decade, a great deal has been written regarding the application of fused [1] porcelain work in connection with crowns and bridges, and a great deal of time and effort is being expended upon a line of work which is never likely to yield the results looked for, except in the hands of an expert. Apart altogether from the expenditure of time necessary for the attainment of even moderate success, there remains the almost insuperable element of weakness due to the fact that fused porcelain is inferior in strength to that produced by the manufacturers; and whatever need there may have been for employing fused porcelain in the past, it is now superseded

[1] Throughout these chapters the term "fused porcelain" is used to denote porcelain as made by the dentist, while the term "manufactured porcelain" is employed in connection with the manufactured article such as plain teeth crowns, porcelain rods, etc.

by the use of manufactured porcelain in the form of tube teeth and porcelain rods, which in texture, appearance, and strength surpass any porcelain which we can produce under less favourable conditions and with the limited knowledge which we possess compared with those who have made the manufacture of porcelain teeth their special study, indeed their life-work. From the claims generally advanced in favour of built-up crowns of porcelain on a platinum base, one would suppose that the advantages claimed are unobtainable in any other way. In reality they are the claims which are brought forward for all ready-made crowns, and readily fulfilled by most of them, though from what has already been said regarding the various forms of these which have been, and are, before the profession, it will be seen that little can be said in their favour when compared with the tube crown. The built-up crown, indeed, owes its good qualities in many cases to the porcelain facing — nearly always some form of the plain tooth.

The following claims for the application of porcelain body in this connection are those usually advanced as being the most powerful arguments in its favour. These are — æsthetic, hygienic, and mechanical. With regard to the first, it is true that there is an absence of display of gold. On the other hand, the tube tooth has the advantage over the built-up crown in so far as it already provides the requisite form and necessary bulk of porcelain, and is better than a crown formed from a facing or veneer built up with porcelain body, as such added porcelain, being different in colour and texture, usually alters the colour and translucence of the

facing, while, as we have already seen, it is inferior in strength.

The hygienic claims stand on surer ground, but there is less in them than their advocates would have us believe if the tube tooth crown is skilfully constructed.

There is also the mechanical question, which resolves itself into one of strength of material. We have seen that the porcelain of the manufacturer is stronger than anything which we can hope to produce, and this is so well recognised that those who favour built-up porcelain crowns make a point of insisting upon every effort being made to reinforce and strengthen the platinum base with a view to placing as little dependence upon the strength of the porcelain as possible; and this precaution is undoubtedly necessary when one considers how weak is the union between platinum and porcelain, and how feeble the union of the porcelain facing and the fused body is apt to be.

The question of the time spent upon the building up of a porcelain crown is one which is seldom touched upon, but those who have done such work themselves, or seen it done by others, are well aware of the tediousness of the process, which is further increased by the necessity for slow cooling. For this it is wisely recommended to let the investment remain in the muffle over night to allow it to cool gradually; unless this precaution is taken, brittleness of the porcelain results. The makers of artificial teeth recognise perfectly well the importance of slow, careful cooling or annealing to obtain strength and toughness, though it is doubtful if they always act in accordance with their knowledge. All this

means the expenditure of time, and while this is a matter of importance, one would not grudge it if the results corresponded, but that these often fall short of the desired result is obvious to those who have had practical experience and have also noted the work of others. This is not to be wondered at when one considers the difficulties to be overcome and the exceptional skill required to obtain good results, points which most writers lay particular stress upon, and doubtless with good reason; but these only serve to emphasise by contrast the simplicity in the use of the tube tooth or porcelain rods for crowning purposes, whereby artistic results, along with other advantages already pointed out, are obtained by the simple process of grinding to the required form. Thus one avoids the many pitfalls incident to porcelain dental art, in which so many calculations must be made in order to avoid the dangers of shrinkage, not to mention those of colour and strength, which are an ever-present menace to the work of the dentist.

The foregoing arguments apply with even greater force when porcelain is used in the construction of bridges; while on the other hand, manufactured porcelain, owing to its greater strength, "toughness," and other qualities, presents the ideal material for this purpose.

CHAPTER V

PRELIMINARY PREPARATION OF ROOTS FOR CROWNING AND BRIDGING

THE preliminary preparation of roots for crowning and bridging will be only briefly dealt with, as it is assumed that the reader is acquainted with the general principles which govern root treatment, and preparation.

The first step, then, is to make a thorough and careful examination of the mouth, and to decide which teeth or roots are likely to prove serviceable. Some may have to be relegated to the doubtful class and so retained until treatment has proved them worthy or unworthy of retention. Those which are loosened from much absorption of their alveoli, or are the seat of abscess with extensive caries involving their walls, or are so permeated by decay as to afford doubtful anchorage, should be removed, as well as all calcarious deposits, and the teeth should be carefully polished and the gums put into a thoroughly healthy state.

Devitalization and Extirpation of the Pulp

The question of devitalization as a preliminary step to crowning is one which some writers seem to approach with timidity, and the reason for such caution does not seem to be well founded. Experience has proved that the life of a tooth deprived of

its pulp is as long, and in many cases longer, than when the pulp is left alive, assuming that the various steps of the operation of pulp devitalization and extirpation have been thoroughly and carefully carried out. Devitalization proves most successful between, say, twenty-five and fifty years of age. Before and after this period the percentage, while still large, is not so great. The dangers arising from the crowning of teeth in which the pulp has not been removed are so great that few experienced operators care to run the risk involved in its retention. The saying that every rule has its exception applies here as elsewhere, and where there are sound reasons for believing that extensive or complete calcification of the pulp has taken place, and that the chances are remote of being able to remove satisfactorily what remains, then such teeth may be crowned with but slight probability of future trouble; but a careful record of their condition should be kept, in view of possible pain or discomfort later on.

The necessity for devitalization of the pulp having been decided upon, the method whereby this may be accomplished will depend upon the nature of the case and attendant circumstances. These vary widely, and in consequence the methods of treatment exhibit a considerable choice of procedure; this must always be exercised with a view to accomplishing the desired end with the smallest amount of pain to the patient, the least risk of subsequent trouble, and in the most expeditious manner possible. Among the agents employed are cocaine, arsenious acid (As_2O_3), the application of ice-cold water, or a general anæsthetic, such as gas. While cocaine finds an increasing number of advocates, and is to be preferred where

it can be employed successfully, there are many cases in which a considerable amount of cutting is necessary in order to obtain sufficient access to the pulp to permit of its exposure, and this operation could not be accomplished painlessly. In the majority of such cases arsenic will be found to achieve the desired result either painlessly or with very little discomfort, provided always that there has been no recent congestion of the pulp or no acute inflammatory condition present at the time, as such conditions often prove a barrier to the successful action of both cocaine and arsenic. The means whereby arsenic may best be applied to the pulp are too well known to call for detailed description, but it may be pointed out that the quantity should be small, and the desired result should be obtained in from two to four days if the pulp is exposed. But devitalization may be accomplished without preliminary exposure, though a longer time is usually required to obtain complete devitalization. An excellent method is to apply a small quantity of arsenic for from twenty-four to forty-eight hours — this is generally long enough to desensitize the dentin sufficiently to enable an exposure of the pulp to be made painlessly when it may be anæsthetized with cocaine in the usual manner by pressure; but care must always be observed not to employ pressure anæsthesia where there is reason to believe that the pulp is septic, otherwise there is danger of infecting the apical space and so setting up pericementitis. High pressure anæsthesia may also be successfully employed even in a tooth in which there is no cavity.

Acutely inflamed pulps. These can seldom be painlessly destroyed by means of the agents spoken

of, and the methods commonly employed of applying soothing dressings such as oil of cloves, carbolic acid, etc., frequently fail to accomplish the desired result of relieving the acute pain in a reasonably short time. Relief must be had for such cases, and quickly. To accomplish this the writer has found the following plan to be most successful; it is based on the application of cold water. Take a couple of 2-oz. slip-joint syringes, and fill one with water of about 70° F., or sufficiently cold to cause only slight discomfort; fill the other with water of about ten degrees lower than the first. Place the saliva-ejector in the mouth, and with the first syringe direct the stream of water upon the crown of the tooth and into the cavity if there be one, using about half the syringeful. Quickly change it for the second syringe and while this is being used the assistant should fill syringe No. 1 with cold water at about 50° F. This is used immediately after the previous one, and while this is being done have syringe No. 2 filled with ice-cold water and proceed as before. Usually this is sufficient to allow the operation to be proceeded with, but if not, a second syringeful will generally so anæsthetize the tooth that by means of a large bur run at high speed, or with a sharp excavator, the pulp may be cut into quite painlessly or with very slight pain indeed. While this is being done, the assistant is to keep up a steady stream of ice-water on the tooth and bur, or ethyl chloride spray may be used. Where sufficient accessibility can be obtained it is preferable to follow on with the latter instead of continuing with the cold water, as more pronounced anæsthesia may thereby be obtained. The ice-cold water is, however, sufficient, and moreover,

is, generally speaking, more manageable. The secret of success in this is in the gradual and continuous application of the cold water. Once free hæmorrhage has taken place, relief is instantaneous and generally complete. Indeed it is most marked in those intractable cases in which there has been no exposure, or where it has been so minute that no expansion of the pulp into the cavity has been possible, and in consequence of which there has been extreme pressure resulting in marked pericementitis. Relief having been obtained in this way, a dressing of oil of cloves or similar soothing application should be sealed into the cavity and allowed to remain for twenty-four hours or longer, when the pulp will usually be found to yield readily to cocaine or arsenic, if in the meantime it has not died.

There are, however, a fair number of cases of congested pulps of a passive or even semi-acute type which seldom merge into the acute form even when their devitalization is sought by means of As_2O_3. These may die without any pain, in which case they may be treated in the ordinary way. It sometimes happens that twenty-four hours or two or three days after arsenic has been applied to a tooth, in which there has been no exposure of the pulp, the tooth exhibits extreme sensitiveness to thermal changes, and mostly to heat — indeed, cold generally relieves the paroxysms of pain, which are usually of an intermittent character — and these symptoms, if no endeavour be made to treat them, will continue for days. Relief in such cases can be had at once by cutting down and exposing the pulp, and this may be done without causing pain, as the dentine will be found insensitive though the pulp be alive. Such

cases may be dressed for a day or two, when the pulp will either have died or its devitalization may be painlessly accomplished by a second application, of either arsenic or cocaine. It is a good plan, indeed, always to open in the above manner into the pulp of a tooth which has exhibited symptoms of hyperæsthesia after As_2O_3 has been applied for twenty-four hours or longer.

General anæsthesia by means of nitrous oxide is an efficient and ready means whereby the operation of pulp extirpation may be made easy of accomplishment, provided free access can be obtained to the canals. The gas or gas and oxygen may be given in the usual way, and when the patient is anæsthetized, or nearly so, the administration may be continued by means of the nose-piece and so maintained with ease for any reasonable length of time — even from ten to fifteen minutes — or gas may be combined with ethyl chloride.[1]

Removal of the pulp. Assuming that the pulp has been anæsthetized or its vitality destroyed, the next step is to remove it entirely. A fair proportion of pulps present obstacles to their complete removal and these are more pronounced with multi-rooted teeth. In the majority of single-rooted teeth, the removal of the pulp may generally be accomplished with little difficulty, while it is frequently impossible to remove the pulp of multi-rooted teeth owing to the small and tortuous character of the canals, as well as the presence of pulp-stones, particularly in the third molars, the buccal canals of upper, and the

[1] This method generally has advantages over all others where the services of a specialist (anæsthetist) are available, as the operator is free to devote his whole attention to the removal of the pulp.

anterior canals of lower molars. To facilitate this part of the operation it is well to cut freely, and so expose the whole floor of the pulp chamber. Such canals as are too constricted to admit of the removal of the pulp by means of the smallest size of pulp extractors and cleansers should be enlarged by means of suitable drills and broaches. For this purpose Beutelrock's (Fig. 55) and Gates-Glidden

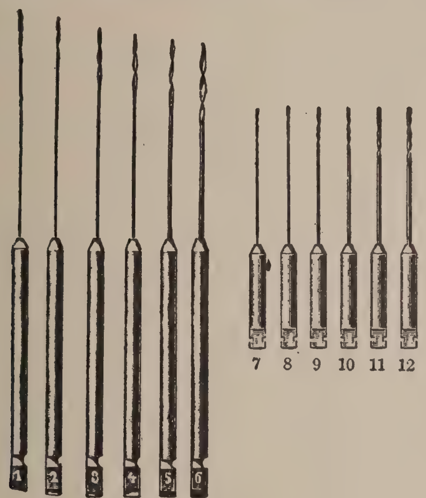


FIG. 55. Beutelrock drills.

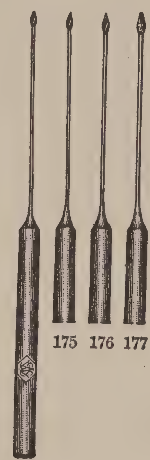


FIG. 56. Gates-Glidden drills.

(Fig. 56) nerve canal drills — the former in six sizes, Nos. 7–12 for right angle, and Nos. 1–6 for straight handpiece — are among the most useful forms. After the removal of the whole of the pulp from the canal, which may be accomplished in the majority of cases in the manner suggested if sufficient time and care are taken, such canals as do not require to be utilized for the purpose of supplying anchorage for a crown or bridge may be filled at once by means of either chloro-percha and gutta-percha points, zinc chloride

cement, or other permanent root filling material or the canals may be dressed, and filled at a subsequent sitting. When there is reason to believe that a canal may require to be utilized later for the purpose of inserting a post or dowel to carry a crown or bridge, it is a good plan to use a gold or other metal post instead of gutta-percha points to fill the canal, and this should be smooth, not roughened, and allowed to project into the cavity of the tooth, so that if necessity arose it could easily be removed.

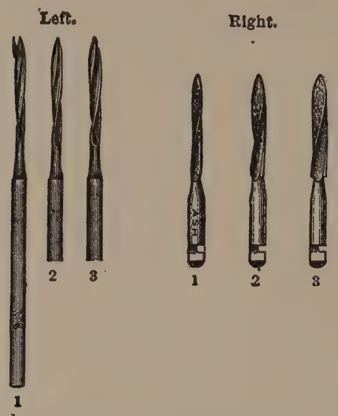


Fig. 57. Peeso reamers.

Where it is found impossible, owing to abnormal conditions, to remove the whole of the pulp, the canal should be filled with a paste composed of zinc oxide and oil of cloves, to which should be added hydronaphthol or other suitable permanent antiseptic. Canals which require a post or dowel for the attachment of a crown, or for anchorage of a bridge or like appliance, should have their canals enlarged to near the apex with suitable drills and reamers, and for this purpose the drills already mentioned may be used, followed by Peeso's reamer, sizes Nos. 1–3 (Fig. 57). The writer has been in the habit of using a Peeso reamer a size smaller than No. 1, and has found that it bridges over a gap between the largest size of Beutelrock or Gates-Glidden drill, and the No. 1 Peeso reamer which sometimes appears too great. This smaller size will be found particularly useful for opening up the canals of

lower incisors and canines. Other sets of instruments will doubtless be found equally effective; the selection of these is a matter of individual preference.

During the process of enlarging the canal for the reception of the post, great care should be exercised to employ the various drills and reamers in the order of their progressive sizes, and to note carefully the direction and length of the canal. This will be facilitated by the frequent use of a gauge for ascertaining its length, and a suitable one for the purpose

Fig. 58. Smooth bristle with rubber disk for measuring canals.

may be formed of a probe furnished with a small perforated rubber disc (Fig. 58.)

During the process of enlarging the canal it should be kept flooded with eucalyptus oil, which acts as a lubricant and facilitates cutting; and while at the same time it keeps the instrument cool, it affords the advantage of the work being done under perfect aseptic conditions.

While the opening up and enlargement of the root-canals can be satisfactorily accomplished by means of hand instruments only, and doubtless with greater safety, the employment of the dental engine facilitates and expedites the work. At the same time the delicacy of touch which is associated with the use

of hand instruments is to some extent sacrificed, and the danger of perforation increased, but this is slight if reasonable care and skill have been used. There is however, always the danger of accidentally breaking an instrument in the canal — a much more serious matter in the case of a lower than an upper tooth, as gravity favours the removal of the broken piece from the latter. Cases are rare indeed in which the broken piece cannot be removed by the exercise of patience and skill, and there are several instruments designed with the special object of dealing with such cases. At the same time it is better to anticipate the possibilities of an accident of this kind, and so the drill or reamer should be carried only a short distance each time and then withdrawn. This should be repeated until the canal is thoroughly opened up nearly to the apex, when it should be sealed.

Sealing the Apical Foramen. This can be most satisfactorily and easily done after the canal has been opened up to the full extent necessary for the adjustment of the post; but where the root has been a pulpless one to begin with, it is often best to defer the operation of sealing until the crown or bridge is completed and ready for final setting, and the operator has fully satisfied himself that the canal is aseptic.

With regard to roots which have been filled at a previous operation, it is of importance to ascertain that their hygienic condition is sound, and if on careful examination a doubt should arise with regard to this they should be once more treated and brought into a thoroughly satisfactory state. The importance of this is manifest when it is remembered that

the permanence of the work is dependent upon the maintenance of an aseptic condition. From time to time a great many different materials have been used for sealing the apical foramen, but zinc oxychloride cement and gutta-percha are those which now find most favour, and either of them gives entirely satisfactory results when properly used. The method employed with regard to zinc oxychloride is as follows: Thoroughly clear the canal of all traces of débris and wipe it out with alcohol, followed by cotton and the root-drier. Then flood it with oil of cloves, once more wipe it out with cotton, and finally dry thoroughly with the root-drier, which should be used until there are indications of beginning discomfort. The use of the hot-air syringe alone is not sufficient, as the upper part of the canal cannot be thoroughly dried by this means. The zinc oxychloride should now be mixed thin, and carried to the end of the canal by means of a broach or other suitable instrument around which a little cotton has been wound, and the cement gently pumped into place, care being taken not to force any of it through the foramen. The broach should be carefully withdrawn and a suitable small blunt-pointed canal plugger employed to compress the cement while it is still soft, so as to eliminate the chance of the production of any minute air-bubbles which might result from the suction action caused by the withdrawal of the broach; or a small quantity of the cement sufficiently firm to be held on the end of a blunt-ended canal plugger should be carried directly to the apex, and gently tapped into place. With regard to sealing with gutta-percha, the preliminary steps to be followed are the same as

those described for zinc oxychloride, except that the canal should be lightly wiped out with eucalyptus oil on cotton. A suitably shaped small cone of gutta-percha, which should first be dipped in eucalyptus oil and the surplus oil shaken off, is then carried by means of a blunt-pointed plugger to the end of the canal, and forced gently but firmly into place; or chloro-percha may be used instead of eucalyptus.

The foregoing observations with reference to the means employed for obtaining access to the root-canals of those teeth which have called for devitalization are applicable also to those numerous cases in which the pulp has died previous to any opportunity having been offered for treatment. These are generally septic and may be the seat of acute or chronic pericementitis and the subject of alveolar abscess, with or without a fistulous opening. The causes which give rise to these conditions are various and need not be dealt with at length, but the active cause is, of course, the invasion of micro-organisms. The symptoms may be non-existent, but there is usually discolouration, with or without subacute or acute pericementitis. The treatment consists of first applying the rubber dam, if possible opening freely into the pulp chamber as far as practicable in a direct line with the axis of the tooth, so as to obtain access to the canals. In single-rooted teeth this is usually easy of accomplishment, while in the molar region access to canals as already stated, is often very difficult; it may be facilitated by the use of 25 to 50 per cent solution of sulphuric acid conveyed to the canal by means of a platinum point. The walls being thus softened, the action of the acid may be limited by the application of a solution of sodium

bicarbonate; or access to the canals may be obtained by the use of Ward's sodium and potassium preparation.

Care must be taken, where no pericemental trouble exists, to avoid setting this up by a too vigorous instrumentation. After the canals have been opened up as thoroughly as prudence dictates, they should be dressed with tricresol or one of the essential oils; for this purpose there is none better than oil of cinnamon or oil of cloves; the former, however, should not be used for the front teeth or bicuspids, owing to its tendency to turn the teeth yellow.

Where a blind abscess is situated at the end of a root, it will often yield to the treatment thus described, but it will be unsafe to seal the apices of such canals until all trace of sepsis has gone, or the case has shown itself one of those in which more vigorous measures must be adopted. Such cases will generally be found to resist treatment owing to a necrotic condition of the tissues about the apex of the root, and can usually be brought into a healthy condition by cutting down on to the end of the root through the gum. This may be done almost painlessly in some cases by freezing with ethyl-chloride (the injection of cocaine being contra-indicated in some cases owing to the danger of extending the area of septic infection); a much better plan, however, is to employ a general anæsthetic, gas being the safest and most reliable. After cutting and scraping the necrosed tissue, and, if need be, amputating a portion of the end of the root, the canal of which should have been previously filled to the apex with zinc oxychloride or chloro-percha, the wound may be packed with antiseptic gauze, renewed daily until

it has healed up, when crowning may be proceeded with.

If a fistulous opening exists in connection with the abscess, the opportunity may be taken, after the canal has been thoroughly opened up and treated as already described, to pump through the canal and fistulous opening a mixture of equal parts of carbolic acid and tincture of iodine, until it appears on the gum, and continue dressing the canal until it is aseptic. In most cases of alveolar abscess invaluable assistance may be obtained in ascertaining the condition of the tissues around the apex of the roots by means of skiagrams, and this aid to a satisfactory diagnosis should generally be employed.

The Use of Tube Posts [1]

Where time does not permit of thorough root treatment before crowning, the author has found the plan which he advocated many years ago, and described in the "Dental Cosmos" for September 1901, to be highly satisfactory. This consists of the application of a tube post instead of a solid one. These tube posts are often of great advantage in economizing time and allowing the operator to proceed with the more permanent structural part of the work, while the tiresome routine of root treatment is in progress. When a root which is the seat of a chronic abscess has to be crowned or utilised as a bridge abutment, and does not yield to treatment within a reasonable time, there is much to be said for subjecting it to a period of probation before finally and permanently sealing its apex. If such a

[1] From "Pot-pourri of Practical Hints," (No. II) by the author, "Dental Cosmos," September 1901, page 984, etc.

probationary period be deemed necessary, obviously the patient must remain without the appliance (crown or bridge) until the operator considers that he may safely proceed with its construction. To many patients such delay is irksome, and it is particularly trying to those who reside at a distance and those who must have the required work done within a limited time owing to social or business calls, but who at a subsequent date could spare time for thorough treatment. From their point of view, as well as from that of the dentist, any plan which will shorten treatment is of importance, therefore in such cases the employment of tube posts will be found an excellent time-saver.

Tube posts are used in all respects exactly like solid posts. Two points should, however, be carefully noted: First, that the joint of the tube should be soldered along its whole length, as the maximum amount of strength and rigidity is thereby obtained: Second, that before soldering the tube post to the cap the lumen of the tube should be filled with some substance which will prevent it from being soldered up in the subsequent step of crown or bridge construction. For this purpose some fibres of cotton or a splinter of wood dipped in asbestos and plaster paste, or chalk and water may be placed in the tube; either is equally good and is easily washed out afterwards, leaving the interior of the tube clear. The strength of these tube posts is, for all practical purposes, equal to that of solid posts, and they permit of the continuance of root treatment after the crown or bridge has been set in the mouth, either temporarily or permanently as seems best to the operator. To permit of the canal being dressed so as to make

it aseptic while a temporary crown or bridge is in place, the tube post may have a few fibres of cotton wound around it and be dipped into cinnamon oil or other suitable antiseptic before forcing it into place. The dressing should be supplemented by one in the tube. Moreover, the tube post may have three or four tiny holes drilled through it — and these will not appreciably weaken it, but permit the dressing to soak through the root. When any extra strain has to be borne, the tube post may be reinforced at the coronal end by soldering a very thin section of tube, about one-eighth of an inch long, to the outside of the tube post.

To prevent the apex of the canals being accidentally sealed by cement or gutta-percha when it is being permanently set, a small pellet of cotton dipped in an essential oil may be placed at the apical end of the canal and the interior of the tube post similarly lubricated. After the crown or bridge is cemented to place the cotton pellet is removed through the tube by means of a roughened broach or bristle; or several strands of waxed silk may be drawn through the tube and the ends allowed to project slightly at the apical and sufficiently at the proximal end to permit of its withdrawal, when the crown or bridge is cemented to place. Any excess of cement or gutta-percha can thus be readily withdrawn, while it is still soft, the tube finally cleared of all fragments, and the apex left open. When the root has been dressed to a healthy condition, the foramen can be sealed and the root filled in the ordinary way.

From the above it will be evident that the principle of root intubation in crown and bridge work brings

within immediate and complete treatment (as far as the mechanical part of the work is concerned) certain cases which formerly could not be dealt with, much less finished, except under the most favourable condition of professional attendance. For example: — sometimes badly abscessed front roots have to be made immediately presentable, when to seal in a dressing for any length of time, much less put on a crown, would be dangerous, or where the patient may not be able to give for days or weeks the time necessary for thorough root treatment, and yet has to have a crown or bridge put on. Further, when out of reach of professional help a patient may be able to remove a dressing from a root which threatens to give trouble or continue the re-dressing of a root after receiving some elementary instructions and being supplied with the necessary instruments.

From the foregoing it will be seen that tube posts afford a ready means of postponing treatment until a favourable opportunity arises, while they do not necessarily prevent the mechanical part of the work being completed. Other advantages of their use will be apparent, such as their employment in cases where accumulation of gases demands some vent. In the crowning of roots whose apical foramina have been enlarged either from persistent abscess or some other cause, these tube posts have a markedly successful application. Other uses of the tube post will be subsequently dealt with.

Hypertrophy of the Gum

Among the obstacles often encountered in the preparation of roots for crowning, hypertrophy of

the gum takes a leading place, and treatment, as a preliminary step to root trimming and shaping, is often essential. Not infrequently such hypertrophy of the gum is accompanied by that of the pulp also; fortunately, when that occurs the pulp will be found comparatively insensitive; at all events it is rarely responsive to thermal impressions unless these are extreme. The worst cases to deal with are those in which the roots are almost entirely hidden from view by excessive growth of gum, the removal of which as already stated must be accomplished before root trimming can be proceeded with. There are various methods by which this may be done, the selection of the most suitable being generally dependent upon the local conditions met with. Thorough freezing by ethyl chloride answers admirably, and results in the smallest amount of hæmorrhage, and in consequence the least interference with the field of view. The adjacent living teeth should be protected, and to accomplish this a celluloid matrix may be applied and filled with wax, or a piece of thin sheet wax may be moulded over them. *The gum should then be thoroughly frozen*, when a large spoon excavator may be used to cut away the excess of gum, and if need be, of pulp; or complete anæsthesia may be obtained by the injection of cocaine. Where the hypertrophied gum is not excessive, or too adherent to the root margin, free exposure of the root may be accomplished by

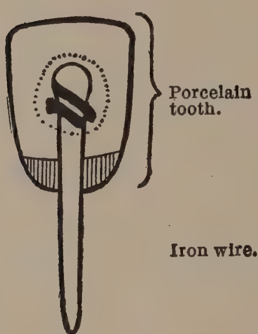


FIG. 59. Dotted line indicates soft solder covering end of wire and pins of tooth.

compression of the tissues by means of temporary gutta-percha, the retention of which in place is made more secure by the insertion of a headed post of wood into the canal and then the gutta-percha packed around it and under the free margin of the gum, and also against the adjacent teeth. Frequently, however, the best plan is to employ a temporary crown (Fig. 59) for the purpose, and in the case of one of the upper front teeth this often becomes a practical necessity if temporary disfigurement is to be avoided. For this purpose a stock of temporary crowns should always be on hand either with tubes or solid posts, and these crowns may be either plain or tube teeth. As accuracy of fit is not necessary, the selection of such temporary crowns need not be large.

Fig. 60. Tube fitted into wide canal and filled around with amalgam. Post is fitted into tube.

The foregoing condition is often associated with extensive decay, so extensive, indeed, that it may preclude the possibility of accurately fitting a band to the root, without recourse to preliminary building up to or above the level of the gum. Usually this is best carried out with amalgam combined with cement — the latter, of course, being covered with the amalgam. The method of anchorage will depend upon the conditions present and the nature of the crown to be used. In the case of one of the upper incisors or canines, anchorage may be readily obtained by means of a tube cemented into the root, (Fig. 60), and if the root is hollowed out by decay, this is rendered all the easier.

Root Perforation [1]

Among many difficulties met with in the preparation of roots for crowning, perforation is one of the most troublesome we are called upon to deal with, and previous to the use of copper amalgam successful treatment was rarely looked for; and when the methods consisted of covering the perforation with gutta-percha or fitting a piece of quill or metal over it, it is not surprising that success was seldom obtained. Indeed, where a post was used, it is difficult to see how success was ever attained at all. The case was different, however, when a crown was employed which did not necessitate the use of such anchorage.

Before describing the methods of employing copper amalgam it might be well to mention the varieties of perforations met with, and these may be roughly divided according to their causes into two classes: — (1) *Traumatic*, accidental in root drilling; (2) *Carious*, as the result of caries. The traumatic variety is usually deep in the root and small in area, and is the more amenable to treatment if undertaken soon enough to prevent the intrusion of the pericemental membrane into the canal.

The second variety generally occurs about the cervix, and is often very extensive. When perforation of either kind occurs, it is followed, as indicated above, by intrusion of the soft tissues subjacent and by more or less continuous pain; the intruding soft mass becomes irritated by the sharp edges of the aperture until it becomes inflamed and gangrenous, sloughs, or gives rise to abscess.

[1] From a paper by the author, in the "International Dental Journal," June, 1897, entitled "Root Perforation: A New Method of Treatment."

The preliminary treatment for this condition, whatever the position or extent of the perforation may be, should be conducted with a view to displacing the soft tissues from the canal, and this can best be effected by packing it tightly with cotton dipped in oil of cloves or eucalyptus, or suchlike antiseptic dressing, and sealed with gutta-percha. The dressing, if need be, may be repeated at intervals until this is accomplished. When the parts are brought into healthy condition the apical portion of the canal may be filled if this has not been previously done, and attention may then be directed to the perforation. It is here that the advantages of copper amalgam over any other material are made evident, as owing to its plasticity it can be readily and easily adapted to the tissues overlying the lesion without danger of displacing them; besides, it is non-irritant, insoluble, antiseptic, and becomes hard and resistant within a reasonable time, and capable of bearing considerable pressure without being readily displaced.

If the canal is not already sufficiently large, it should be further reamed out, care being taken not to encroach upon the perforation, and the enlargement should be increased at the proximal end of the root, with the object of obtaining as good a view of the perforation as possible, without unduly weakening the root. The apex having been filled, a small quantity of thin copper amalgam should be carried to the end of it, and a tapered steel instrument gently pushed through the soft amalgam until it reaches the sealing material. This should be worked with an even rotary motion, so as to spread the copper amalgam evenly around the interior of the canal, when it can be withdrawn, and a steel or German-

silver dowel, slightly coated with wax and sufficiently long to project a little way from the canal, should be carried to the apex, and then copper amalgam gently tamped around between the dowel and the walls of the canal, so as to fill it up completely, care being taken not to use sufficient pressure to push the copper amalgam beyond the perforation (Fig. 61). The case may now be left from twenty-four to forty-eight hours, to allow the copper amalgam to become thoroughly hard, when the temporary dowel may be easily withdrawn after slight heating by means of a hot instrument applied to it.

Fig. 61. Steel pin in canal with copper amalgam packed round it, and filling perforation in side of root.

Should nothing more than slight discomfort follow — and there ought to be none if the foregoing instructions have been followed intelligently — then crowning or bridging may be proceeded with, reasonable care being taken to avoid displacing the amalgam.

Another class of case which is also difficult to deal with is that of fractured roots, and the treatment of these is often very puzzling. If the fracture is a bad one it may be necessary to remove the root, but unless the fracture is extensive and considerable time has elapsed before it has received attention, the conditions will usually yield to treatment — the particular method of which will depend on whether the whole or only part of the fractured root has to be retained. Assuming that the whole may be retained, then the parts should be drawn close together by means of a strong wire twisted tightly

around them. A strong band and cap may then be fitted, and the crown completed as far as practicable in the usual way. In such cases the crown should always be cemented on. Results are, however, uncertain.

There is yet another class of case which may be dealt with at this juncture, namely, the fracture of a post in a root. This accident is one which we are called upon to face from time to time; and while the simple cases are easy to deal with, there are some which are difficult. They naturally group themselves under two headings, viz: — (A). Those in which the broken pin can be removed; (B). Those in which the broken pin either cannot be removed or else where its removal would probably result in perforation, fracture, or some form of permanent damage to the root. Sometimes a sufficient amount of the post remains to permit of its removal by means of an efficient post-extractor (Fig. 62 S. S. White Post Extractor). Usually, however, the cement and dentine surrounding the broken post require to be removed by drilling in order to permit of the end of the post being grasped. When this can be successfully done without incurring the

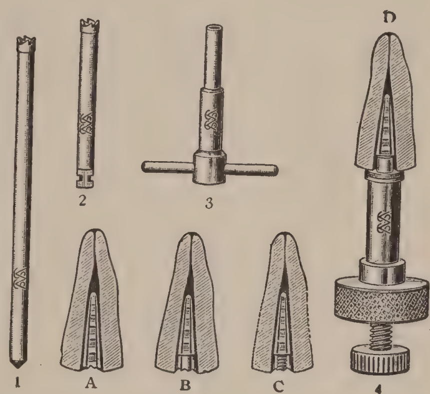


Fig. 62. S. S. White Post Extractor. 1, Trephine for direct, and 2, Trephine for angle handpieces. 3, Screw-stock. 4, Post-extractor. A, B, C, D, Post and root at various stages of the operation.

dangers spoken of, the removal of that part of the post which has been left in the root becomes a simple matter. When the post has been fixed with gutta-percha or gutta-percha and cement, its removal is easier than when cement alone has been used, and as an aid to its removal where gutta-percha has been employed the post should be heated by means of a blunt-ended root-drier. When it has been found impossible to remove the remains of the post the case may be effectually dealt with in the following manner; if the post is other than a round one — for instance, similar in form to the Logan-use a trephine the inside diameter of which is slightly smaller than the cross section of the crown end of the post (Fig. 63) and this will serve to round off the corners and so prevent the necessity for using too large a trephine, which might result in undue weakening of the walls, or even perforating them. Continue to trephine as far as possible, consistent with the avoidance of the danger indicated; that will in most cases be at least one-eighth of an inch, and this will be found to afford ample anchorage if the following plan is carried out:

Fig. 63. Trephine cutting edges from Logan pin.

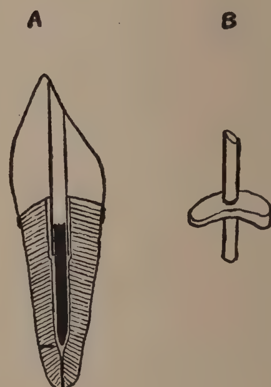


Fig. 64. Method of crowning with broken post in canal: A, Tube encircling broken post in root canal, and soldered to cap and band with tooth fitted over tube. B, Shows tube and cap.

Into the groove made by the trephine a tube of gold is fitted and soldered to the cap, and the crown is then fitted in the ordinary way. This device gives the most secure grip with a minimum sacrifice of tissue, and it will be noted that such a tube, band, and cap really afford a triple grip: Firstly, the tube grasps the broken post; Secondly, the tube is held externally by the surrounding dentine; and, Thirdly, the circumferential band secures both (Fig. 64). It will be obvious that such a tube is very much better than a solid post of equal length, the latter being held *only* externally, and the tight encircling of the broken post by the tube renders it once more equal to a solid one.

CHAPTER VI

MECHANICAL PREPARATION AND SHAPING OF A ROOT FOR THE RECEPTION OF THE CROWN

IN the preparation of teeth or roots for crowning and bridging, thorough familiarity with the shape of these, and particularly with their cervical surfaces is indispensable to success in so shaping them that bands and caps may fit with accuracy. But such knowledge alone would be but a poor guide unless accompanied by a cultivated sense of touch and sound, as by this means only can one tell that the enamel has been completely removed. This double sense can only be obtained by practical experience and varies much in individual cases. Before proceeding, then, to a description of the methods employed, it will be well at the outset to make it clear that while descriptive methods are doubtless of value, they can only suggest lines of procedure, as individual methods yielding similar results show wide divergence; consequently no particular method can be given preference. So far, our consideration of the treatment and preparation of teeth and roots has been that commonly followed in dealing with devitalized teeth for the purpose of filling or inlaying, with the exception of such special circumstances as were spoken of with regard to the use of tube posts when therapeutic measures could not be completed. But we have now to consider the mechanical preparation of teeth and roots for crown-

ing, and as no amount of skill expended upon the constructional parts can possibly make up for careless or unskilful root preparation, it is of the utmost importance that each step in the operation of root-shaping should be carried out in the most perfect manner possible, entirely irrespective of the amount of time and labour which it may involve. The various steps seem easy enough, but this is by no means the case with all of them, and the dentist

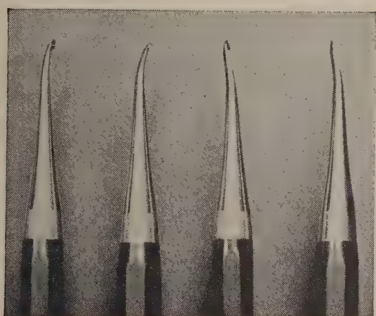


Fig. 65. J. O. Wells' enamel cleavers.

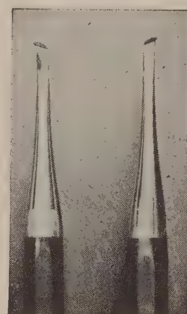


Fig. 66. C. S. Case's enamel cleavers.

who approaches this part of the operation under the impression that it is not of prime importance is bound to repent of his over-confidence or carelessness. It is safe to affirm that there are more failures in crown and bridge work due to imperfect root treatment and shaping of roots than to any other cause. If a proper appreciation of this fact were more general, less would be heard of the failure of crown and bridge work to meet the requirements of mechanical and hygienic efficiency.

At this point it may be well to mention some of the instruments and appliances which will be found useful in the work; and as it has been seen that like

results may be reached by various methods, it follows that the selection of instruments and appliances will depend largely upon individual choice. In any case an extensive assortment of wheels, discs, and points should always be available.

With regard to hand instruments, the following will be found useful for removing the enamel after the tooth or root has been ground down, which should be done to about one-sixteenth of an inch of the gum margin for all forms of tube crowns: J. O. Wells and C. S. Case's enamel cleavers (Figs. 65 and 66). The former, being smaller in the head, are preferable, as they can be more readily introduced between the free margin of the gum and root; also scalers (Fig. 67). All of these instruments should have short heavy handles, which will afford a sure grip and should be held so that the danger of slipping and wounding adjacent parts may be avoided.

Fig. 67. S. S. White scalers Nos. 3 and 7.

Crowns may be described under two main divisions — namely, banded and unbanded. The banded crown calls for the greater skill in root trimming, necessitating as it does the removal of the whole of the enamel from the periphery of the root and the methods whereby this may be satisfactorily, accomplished will now be dealt with.

All roots which require banding must be so trimmed that their sides are parallel or slightly convergent, and this must be done whether the gum has receded beyond the edge of the enamel or not.

For the purpose of describing in a general way the method of preparing a root for banding, one of the upper centrals may be selected. What remains of the crown should be removed to within about one-sixteenth of an inch of the gum. For this purpose cross-cut fissure burs are generally best, the use of excising forceps being seldom, if ever necessary, and always objectionable. Care should be taken to follow with the bur the line of the festoon of the gum without injuring it. Having removed the remains of the crown, the next step is to smooth off the surface of the root with a carborundum wheel. The ring of enamel must now be removed from the end of the root in the following manner. A beginning should be made at the centre of the labial surface, and, a suitable instrument (see Fig. 68) being chosen, it should be introduced under the free margin of the gum, the cutting edge being held close against the surface of the root, when it should be gently pushed up until the edge slips over the ring of enamel. Then, keeping the cutting edge firmly pressed against the surface of the root, a downward pressure is applied,

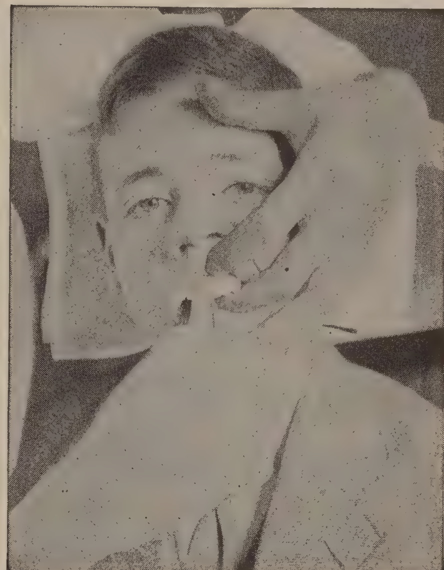


Fig. 68. Shows method of using enamel cleaver.

On repeating these movements several times, the enamel will be found to leave the root in the form of a fine powder. This manipulation is continued until all is removed. Generally speaking, its removal in the manner described is fairly easy, particularly so when it has been disintegrated by decay or where the pulp has been dead for some time. Occasionally, however, the whole or part of the enamel may be more easily and quickly removed from the basal ridge, where it is thicker and more adherent, by means of small stones. These, however, unless used with skill and care, are more liable to injure the gum and so increase the chances of recession. But this danger may be minimized or altogether removed except in cases where the gum is in a hyperæmic condition, by the use of suitably shaped Butler's carborundum points, mounted on porte-polishers and used with the contra-angle or straight handpiece, the former preferably.

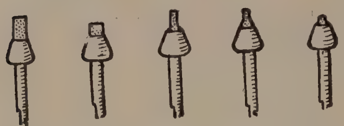


Fig. 69. Different shapes of Carborundum points.

Fig. 69 shows some of the most useful forms, and these may be quickly brought to the required shape by means of an old file held against the carborundum point, while it is being rapidly rotated in the handpiece, or by means of one of the diamond-pointed wheel-truers for the purpose. It is astonishing how extremely fine and small these points may be made, while retaining sufficient strength for efficient grinding. The extreme point may be tipped with shellac to prevent it from injuring the gum, and this method is also applicable to small stones. The points should be short enough to allow the shoulder of the porte-

polisher to rest on the margin of the root (Fig. 70) and so act as a stop in preventing the point from passing too far below the gum. The methods employed in the preparation of the upper bicuspids do not differ materially from those followed in the case of the front teeth.

In the preparation of the upper molars the difficulties are considerably increased. Here the use of stones will be found necessary. Proceed first to grind down the tooth to within one-sixteenth of an inch or less of the gum, then using enamel cleavers and small carborundum points in the contra-angle or straight handpiece, remove the whole of the enamel in the same way as described in trimming incisor roots; as already stated, this will be found a more difficult proceeding, as the enamel is thicker and often extends a considerable way under the gum, and when quite sound offers considerable resistance to its removal. Here short Butler's points and the various forms of abrasive discs will be found useful.

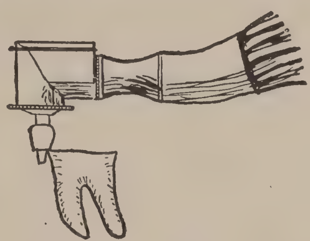


FIG. 70. Showing method of using Carborundum points.

With regard to the lower front teeth, no special difficulties are met with owing to their accessibility. The bicuspids and molars, however, particularly the latter, give greater trouble than any other teeth, with regard to trimming their mesio-buccal and mesio-lingual corners; and again this may be best accomplished by the use of small Butler's points and safe-sided discs, also one of the J. O. Wells enamel cleavers already spoken of. This latter is best used

in the following manner for the left side: Grasp the handle as one would that of an elevator, and, with the side of the ball of the thumb resting on the edge of the lower incisors, or other convenient point, use the instrument as a lever of the first order, the fulcrum being the thumb (Fig. 71). For the right side, the necessary trimming may be carried out by means of wheels and points.

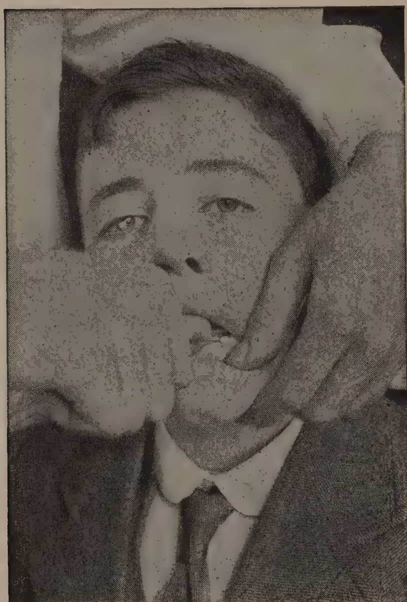


FIG. 71. Shows method of using enamel cleaver on left side of lower jaw.

The foregoing description is that adopted for trimming a root where the application of a tube crown is decided upon. But as all-gold crowns in conjunction with tubes are sometimes used as abutments a short description of the means whereby these can be shaped may be useful. The first step, then, is to grind off enough of the tooth to allow of sufficient room for the gold cusps. Following this the walls may be given the necessary form by means of the various discs and wheels already spoken of. In the use of these, great care must be taken to grasp the handpiece firmly and to keep the disc or wheel thoroughly wet — as, by doing so, not only will cutting be done more speedily, but the chances of the disc either breaking, sticking fast, or jumping

and wounding the gum or cheek, are avoided. If, however, too much is removed in cutting off these contours, a ledge may be formed (Fig. 72), either above or below the margin of the gum, which will present a serious obstacle to the accurate fitting of the band, by acting as a step on which the band will rest, and so prevent it from being forced into place. In the event of such an accident happening before the cut reaches the level of the gum, no harm will follow, and the necessary shaping can be recommenced at the peripheral margin. On the other hand, if the cut has been taken to below the level of the gum line, it may be continued until it has reached the level of the lower border of the enamel, and the band allowed to rest on it, provided always that there is no ledge left outside the band (Fig. 73) in which case the latter must be thickened at this point to bring it flush with the margin of the tooth ledge.

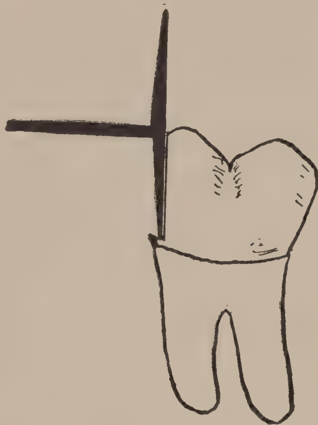


Fig. 72. Showing accidental formation of a ledge in trimming tooth.

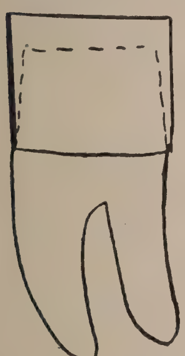


Fig. 73. Showing band resting on ledge.

In order to prevent any such difficulty it is best to grind from the margin rather than make vertical cuts, using for the purpose small inverted cones and cup-shaped wheels; also the various forms of Butler's

points in the contra-angle handpiece may be supplemented by coarse emery-paper and cloth discs.

From time to time, during the process of trimming and shaping careful exploration should be made with probes to detect overhanging margins, while care should be observed throughout to obtain a proper degree of taper to the root.

The foregoing description has had reference to teeth in their normal position, but certain variations are met with which call for special treatment; to this class belong teeth whose approximal surfaces have been invaded by caries and in part destroyed; in consequence the adjacent teeth generally appoximate, and so leave insufficient space for a properly contoured crown. To overcome this difficulty one or other of the following methods must be adopted: Separate the teeth by packing gutta-percha into the space hard against the adjoining teeth, renewing this at intervals till sufficient space is obtained; or accomplish the purpose by some mechanical device; or else by grinding the approximal surfaces of the adjoining teeth sufficiently to permit of a crown being fitted; or by making the most of the available space by fitting a crown with the maximum contour which the space will allow.

Another abnormality commonly met with is that of a molar or bicuspid lying at an angle toward a space from which one or more teeth have been removed. Such cases are usually dealt with easily and satisfactorily when a single crown only is required; but when the teeth on either side of the space converge and the space has to be spanned by a bridge, the problem is not always so simple, though by no means so difficult as represented. The methods commonly

suggested for obtaining parallelism of abutments not infrequently involve the sacrifice of an unnecessary amount of the external surface of the crowns of the natural teeth as well as undue enlargement of their root canals. These methods are uncalled for, as the system of tubed crown and bridge work lends itself readily to various forms of anchorage suitable for these cases.

Preparation of the Surface of a Root for an Unbanded Crown

The preparation of the surface of the root for the reception of a detached-post or dowel crown is similar to that followed in connection with the band, or half-band crown, with the exception that none of the enamel should be removed from the periphery of the root. The subject will, however, be more fully dealt with in Chapter XI.

CHAPTER VII

FITTING THE CAP AND POST PREPARATORY TO TAKING THE IMPRESSION FOR THE CROWN

THE importance of thorough and careful shaping of roots was pointed out in the previous chapter, and a like warning is here given with regard to the fitting of bands for capped roots. It is essential that bands should fit accurately, otherwise they will prove a source of weakness rather than strength.

Those who have not acquired the requisite skill which will enable them to do so, will be able to attain the desired end by the means described below. The fitting of bands to the various classes of roots will be described in the order followed in connection with shaping them.

Various methods are recommended for determining the circumference of the root and for obtaining a model of its outline. Perhaps the most common is to encircle the root with a loop of annealed brass or iron wire about 33 gauge, using a Kirk dentimeter and twisting the wire until the loop fits tightly; or a small pin-vise may be used, and the wire, after being tightened, burnished to fit any irregularities of the root. In the case of the front teeth or bicuspids the ends of the wire loop are most conveniently twisted on the labial surface, whereas in the molars the lingual surface is better. The wire should be carefully slipped off the root and the loop placed

upon a piece of tin or lead. Over this is placed a piece of flat iron, and with a blow from a hammer on the iron the wire is driven into the tin or lead. This gives an exact impression of the root. The wire should then be cut at the point farthest from the twisted ends and each end of the loop straightened out at right angles. A piece of 22-carat gold plate, 28 gauge, or a piece of platinized gold plate 30 gauge of the required width, should now be taken and cut a trifle longer than the wire pattern, so as to allow for slight overlap, care being observed not to use too broad a strip, as the difficulties of fitting are thereby increased. Proceed now to fit the band to the impression made in the tin or lead, and before uniting the edges try the band on the root, and having ascertained that it is of the right size, proceed to join the ends of the band together, either by sweating or soldering them. Usually it is suggested to have the joint interstitially or on the lingual surface, but some prefer to make it on the labial or buccal surface, finding it easier to fine-fit the band to the root and note the amount of overlap. Where sweating is resorted to, it is a matter of little importance where the joint is situated. Sweating is preferable to soldering, but of course requires more skill; this, however, can soon be acquired by a little practice. The method whereby sweating can be accomplished is as follows:—The inner edge of the overlap (Fig. 74) should be bevelled, the surfaces brought into accurate contact, then by means of the soldering tweezers the ends of the overlap should be

FIG. 74. Section of gold band, to show method of bevelling inner edge preparatory to joining. Thickness of gold exaggerated in order to show bevel.

held together while the band is being annealed. After cooling the joint should be coated with thick

FIG. 75. Mandrels for shaping seamless tooth-root collars.

borax. The band should now be grasped with the tweezers at the point farthest away from the joint, which should then be sweated in the Bunsen or

alcohol flame and not by the blowpipe, the flame being turned low so that the heating will be more even and under better control. When the band has become quite red, the borax will be seen to flow. This must not be mistaken for the union of the two pieces, but the heating continued for a moment, when the gold will be seen to flow. The band must then be quickly removed from the flame, and if skill and care have been used, the union of the surfaces will be found to be perfect. The thickened joint may now be either filed down or, if on adjusting the band it is found a trifle too small, it can be easily enlarged by tapping the thickened edge with a riveting hammer on the round spur of the anvil. Another method which yields excellent results, is to take the circumference of the root with a dentimeter, and make a band of the required size and shape it on a mandrel, for which purpose a set of mandrels introduced by the S. S. White Dental Manufacturing Co., are admirably adapted (Fig. 75). There is yet another way which will be found useful indeed sometimes indispensable, where there is much difference in the level between say the lingual and labial, or lingual and buccal surfaces of a root — as, for instance, when decay has extended to or below the margin of the gum. In such cases it is often difficult or even impossible to obtain an accurate outline of the root by means of the wire loop, and here a model is of advantage. It may be obtained in the following way: Take a small piece of dental lac,[1] or modeling compound about the size

[1] First suggested and described by the writer in a paper "A New Impression Material," read before the American Dental Society of Europe, at Cologne, April, 1901.

of the first joint of the little finger, and just pliable, not too soft. Soften the surface with which the impression of the root is to be taken by passing it once or twice rapidly over a Bunsen or alcohol flame, and mould it with the fingers to the surface of the root, pressing it hard into place. If this does not give a sufficiently sharp impression — and it usually does if lac is employed — then remove, chill thoroughly, and replace with a thinnish coating of inlay wax over the surface, and force hard home. Cast the impression with quick-setting cement, or plaster, and fit a band to it, but do not unite the ends until it has been fine-fitted to the root.

Having spoken, then, of the general methods of band construction the various classes may be briefly dealt with.

Front Tooth Bands

Having formed the band by one of the methods described, the next step is to fit it on to the root. It will be found that the line of the gum rises interstitially, thus forming an irregular margin. With the band in position on the root, mark on the outside with the point of a sharp instrument the line of the festoon of the gum (Fig. 76). Remove the band and trim to this line with the crown scissors and repeat the operation until the edge of the band when placed on the root touches the gum all the way round (Fig. 77). The edge of the band should next be bevelled from the outer to the inner edge, after which it should once more be placed on the root and forced to place, then marked on its inner side by means of a sharp instrument in order to show the height of the root.

It should then be once more removed and cut down to the mark. Again replace on the root, and proceed to reduce the surface of the root and band together until no gold shows on the labial or buccal surface, and not more than $\frac{1}{32}$ of an inch on the lingual or palatal (Fig. 78). With regard to cutting down the labial surface, it is well to remember that this should be well below the gum line, as there is the added thickness of the gold cap to be accounted for.

The next step is to solder on the cap. While 22-carat plate, size No. 30, may be used for this purpose, yet it is better in some cases to use pure gold of the same thickness, as it can be more easily burnished to conform accurately to the surface of the root. To remove the band with the least risk of distortion, insert a fine hooked probe beneath the gum margin, slip it over the edge of the band, and so detach it. Now borax the pure gold and place the band upon it, and with the tip of the thumb or forefinger, press the pure gold to place so that it fits the edge all around. Having thus fitted it, borax the joint in the usual way and with a small piece of high-grade solder unite the band and cap. This is best done by holding the cap and band by means of tweezers in the Bunsen flame. Should the joint not be made complete at first, no further effort should

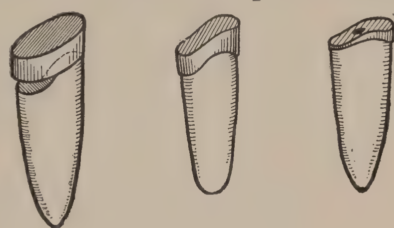
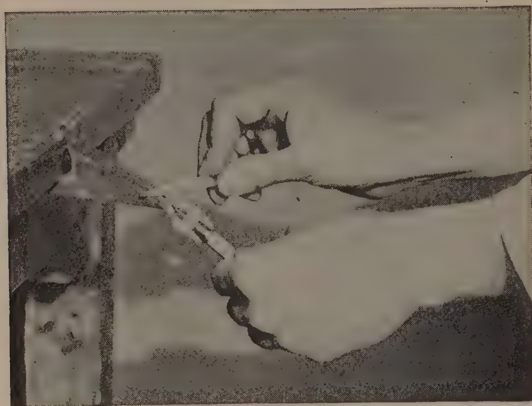


Fig. 76. Band on root showing line of festoon of gum marked on outside of band.
Fig. 77. Band on root after being cut to follow festoon of gum.
Fig. 78. Band after being ground down on root.

be made to finish the soldering until the cap and band are pinched together, when the union may be completed by means of another small piece of solder.



Figs. 79–80. Showing methods of tapering the post.

The excess of gold should then be trimmed off and the cap replaced on the root. If a small hole is punched in the centre of the cap it will be found that it may be forced into place much more easily, for if the band and cap have been properly fitted

they will be found to form an air-tight joint when placed on the root.

The next step is to adjust the post in the canal, the size of which will be determined by the type of root and the strain to which the crown is liable to be subjected. Generally speaking, it should correspond to No. 2 of Peeso's reamers, which corresponds closely with 13½ U. S. Gauge, and this in turn with the tube in the non-platinum tube tooth. The post should be tapered to follow as nearly as possible the shape given to the canal by the reamer, and this may best be accomplished by holding the wire in a pin-vise and imparting to it a rotary motion by holding it between the thumb and fingers and while so doing drawing the file across the wire at right angles, while at the same time it is supported in a groove in the bench block (Fig. 79); or the wire may simply be held in the fingers and rotated at the same time as the filing is being done (Fig. 80). This enables a perfectly round and evenly tapered post to be formed, and can be quickly done after a little practice. At this stage that portion of the post which enters the root may be roughened in the following manner, although it is seldom possible to employ the same method afterwards. Lay the straight length of post wire on a flat block of wood and press the flat face of a medium coarse file hard on to it, and give one or two draws of the file backward and forward. The post will roll and follow the motion of the file, and so an even roughened surface will be secured, which will permit of a much firmer hold being obtained than by the ordinary methods, and without the danger of weakening the post.

Before the cap is placed on the root, the pointed

end of the post is inserted into the canal and pressed home into place; next, the required length, which should be sufficient to reach the incisive edge of the crowns of the adjoining teeth, is measured off. Having removed the post from the root, cut it to the required length, place the cap on the root, and burnish carefully to the surface. Then with a pair of rough-pointed pliers (Fig. 81) grasp the post firmly, place the pointed end through the small hole originally made in the cap, and so force the post home. Now mould a small piece of temporary stopping

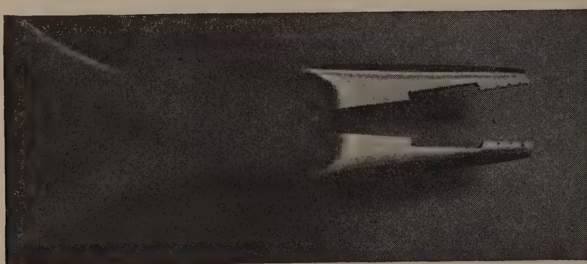


FIG. 81. Roughing pliers.

round the projecting end of the post and force it down on the surface of the cap, meanwhile taking care not to allow the end of the post to project through the gutta-percha (Fig. 82). While still soft, grasp the post through the gutta-percha with the pliers (Fig. 83), the cold metal chilling it sufficiently for the purpose required. Next remove the post, cap, and gutta-percha together — or, if the cap does not come away it can be replaced on the impression in the gutta-percha, where it may be fixed with a touch of sticky-wax. It can now be invested and soldered, using a very small piece of solder to unite cap and post. When doing so, only a very small quantity of investment material need be employed,

and it is to be noted that the whole must be thoroughly heated up before any attempt is made to

FIG. 82. Shows post with temporary stopping moulded around it.

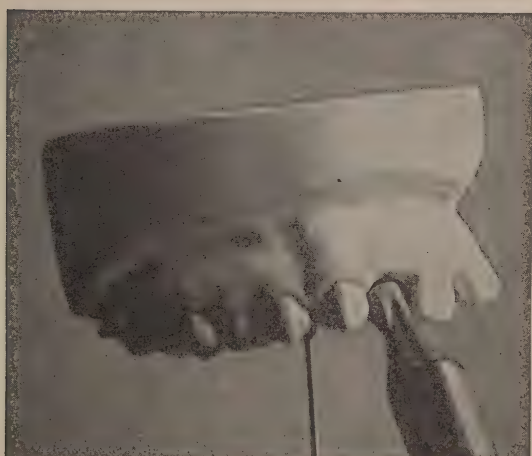


FIG. 83. Shows method of grasping post through gutta-percha.

flow the solder. The cap and post may be soldered together without investing, and in doing so, one

must keep in mind that the pure gold has been turned in along with the post. Now, with a pair of strong tweezers pinch the pure gold firmly against the post, and grasping the tapering end of the post in a pair of tweezers, hold in a horizontal position while carefully withdrawing the gutta-percha. Next borax the joint, place upon it a small piece of solder and flow it by means of a large soft flame in the blowpipe. By this means the time spent in investing and heating up a bulk of investment material is done away with. Of course, it is a more risky method and if one is not confident of his skill, and time be not a serious object, it is safer to invest.

The cap with post attached should now be placed on the root. The pure gold being very pliable and the pin very lightly attached to the cap, cap and band may be burnished to place, and while this is being done it is well to hold the post firmly. The position of that part of the post projecting above the cap must now be considered. It should be in such a position that when the crown is finished it appears on the lingual surface immediately behind the incisive edge. In most cases it will not require bending, but if this is required it is safer to do so when the impression has been cast and the model obtained. To facilitate bending the post, a pin-bender should be used, or a notch may be made immediately above the surface of the cap in the side of the post to which it is to be bent. (Fig. 84.) With regard to the upper lateral incisors, the methods already spoken of are also applicable, with this exception, that as the roots of these teeth are smaller, the canal should be reamed to No. 1 Peeso reamer; then size 32 gauge usually gives a stout enough band

for these. The upper canines, too, are to be treated in the same way as the centrals, care being observed to take advantage of the full length of the canal and thus obtain as long a post as possible, not only because this is an advantage in obtaining the necessary strength which the position and size of this tooth calls for, but also because this root may be required later as anchorage or support for a bridge.

The half-band. The half-band is preferred by many, and is of value in cases where extensive recession or decay has occurred in the labial or buccal surfaces of the teeth. Where it would be difficult or even impossible to adapt a full band accurately, the half-band will usually be found to meet all necessary requirements, but a band which embraces two-thirds of the circumference of the root is preferable, as by its means greater stability and anchorage is obtained. Although such a band does not encircle the whole of the root, it is advisable to trim the root as for a full band. In making the half-band, it would appear to most workers that this is more easily and satisfactorily accomplished by first making a full band and proceeding to finish it up to and including the soldering of the post to the cap. This, however, is by no means necessary, and better results may be obtained both as regards fit and quickness of construction by adopting the following method: No measurements or model are required in this plan, but a strip of gold of the required thickness and of sufficient width should be bent to a U-shaped form, the outline of the gum margin marked, and the gold

FIG. 84. Showing how to bend post by notching with file just above surface of cap.

cut away to conform to it as previously described in the making of full bands. The result will be, in normal cases, a band shaped as in Fig. 85. To this a pure gold cap may be soldered, after which the cap and band should be placed on the root and burnished until it accurately fits. While this is being done, the band should be held firmly against the lingual surface of the root by means of a piece of hard wood, or the point of the forefinger of the left hand. During the process of burnishing, the labial edge of the root will be defined on the surface of the gold cap, as will also the entrance of the canal. The cap and band are then to be removed, and the excess of pure gold trimmed off. Before replacing the cap and band, the surface of the root may be further reduced below the level of the gum by means of an Ottolengui root-facer, or small stone, care being taken to avoid injuring the gum. The post is next adapted in the usual way and soldered to the cap, which is then to be returned to the root. Before burnishing, the post should be shortened so that it will just clear the bite and no more.

Fig. 85. Shows method of shaping gold for half-band.

Passing now to the upper bicuspids, the technique of band-fitting and capping is the same as that for the front teeth. There is, however, an important modification with regard to the post or posts. In the first bicuspid there are nearly always two canals, and sometimes in the second also; but the roots being more slender than in the front teeth, the canals should only be reamed out to No. 1 size Peeso reamer. This will necessitate a slight reduction in the size of the post used, but the same size

of wire may be employed. After the cap is placed in position, the posts are to be adjusted as in Figs. 86 and 87, where it will be seen that they are sometimes parallel, and in other cases considerably divergent. If the divergence be very marked, the more suitable canal may be selected for the stouter post, whereas in the other canal a shorter post may be used.

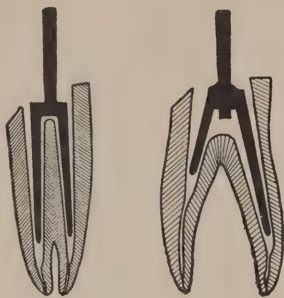


FIG. 86. Showing upper bicuspid with two posts parallel and of equal length.
FIG. 87. Divergent posts in upper bicuspid, one post a short one, to enable cap and posts to be placed on root.

These double posts may be formed in the following manner: — Take two short, straight lengths of wire, tapered to fit the canals and cut flush with the surface of the root, and join these together by means of solder to a straight piece of wire to carry the crown (Fig. 88). In order to do so they should be invested, although this is not essential, as when one has had a little experience the distance apart between the posts which enter the roots can be accurately judged by the eye and the parts united on the soldering-block or a loop may be formed as in Fig. 89, and a straight length joined to it to carry the crown; or a selec-

FIGS. 88 and 89 show posts for double rooted teeth. FIG. 90 shows post bent to angle for tube crown.

tion of these may be kept on hand which with a little adjustment can be quickly adapted to suit any case. When only a single root is employed to afford anchorage, the post may be bent as in Fig. 90 and anchored into one root — generally the lingual, as this is usually the stronger; or a single straight post may be used, as mentioned in Chapter IV.

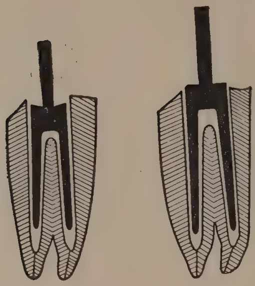


Fig. 91. Shows junction of posts below surface of root. (Correct way.)
Fig. 92. Shows junction of posts above surface of root. (Wrong way).

Whatever method is employed, care must be observed to hollow out the base of the pulp chamber and the entrance to the root-canals with a view to accommodating the junction between the post and the bend in the case of double posts, so that it does not rise above the general level of the surface of the root (Fig. 91), otherwise it would be necessary to hollow out more than is desirable of the base of the crown, which in consequence would be weakened (Fig. 92). The pure gold cap is now to be burnished into the depression made before the post is soldered, and if by accident this should be torn or split and so made too large, a hole should be punched with a rubber dam punch in a small piece of pure gold, which should be slipped over the post and burnished to place so as to fill up the gap. The post and cap are then to be removed in the manner described in the case of the front teeth; or if preferred, a very

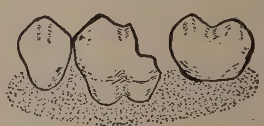


Fig. 93. Showing upper molar with gum receded, exposing buccal roots.

small impression in plaster or dental lac may be taken of cap and post, and these removed and soldered in the usual way.

Coming now to the upper molars, the fitting of bands for these may be carried out by one of the methods already described. There is, however, a type of molar root, both upper and lower, which can be more easily and accurately fitted with a band in the manner presently to be described, than by any other means suggested. The type of case to which reference is made will be seen by a glance at the accompanying diagram (Fig. 93). From this it will be observed that the roots, generally owing to caries or recession of the gum, have been all but divided, and in consequence, in the case of an upper molar — this will take the form of a deep V-shaped space between the buccal roots and a less pronounced but well-marked incurving between the palatal and disto-buccal root (Fig. 94). Obviously, here the difficulty is to get accurate adaptation of the band into the sharp angle between the buccal roots; and the method whereby this may be best accomplished is by so fitting the band that the free ends, which should be tapered from the outer to the inner edge (Fig. 95), are directed into the buccal space, thus forming almost a knife edge, and then soldered. This permits of the band grasping the tooth more accurately and firmly. In the case of the lower molars where a like condition is met

FIG. 94. Shows transverse section of upper molar at about level of floor of pulp chamber.

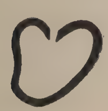


FIG. 95. Shows band for Fig. 93 with proper flanging of edges. Thickness of gold much exaggerated.

with, the band may be made in two sections, one to fit each of the roots, and the free ends of these tapered from the outside toward the inner side almost to knife edge, and then soldered together (Fig. 96). This gives even a stronger grip in the lower than in the upper molar, and is nearly equal to two separate bands when joined together.

Fig. 96. Band for lower molar in which the gum is much receded, exposing space between roots.

As the palatine root is by far the strongest, it should be utilised for reception of the post; and as a fairly long one is usually obtained, it is generally all that is necessary. If, however, owing to some abnormality, such as curvature of the root, or from any other cause, only a short post can be obtained, then a supplementary post may be introduced into one of the buccal roots, preferably the anterior one. Should there be any doubt regarding the sufficiency of the anchorage, this may be increased by shaping the walls of the pulp chamber and burnishing a pure gold cap to fit it. If the cap is frequently annealed, accurate adaptation to the pulp cavity may be had with little difficulty. Should the gold be perforated or torn, an additional piece of pure gold may be placed over the damaged surface and burnished to place (Fig. 97), or a lac impression of the surface of the root may be taken while the band is in position. Remove the impression, and band which should be replaced in the impression. A pure gold cap may then be swaged to fit it by means of S. S. White's or Ash's "crown-swaging device" — which

Fig. 97. Upper molar with pure gold cap burnished or swaged into pulp chamber.

consists of a cylinder plunger and a soft rubber pad. Another method is to chill the impression thoroughly and slightly oil its surface. Take a piece of softened lac about the size of a hazel-nut, and place it on a piece of lead. Press the impression into this, then thoroughly chill with cold water, when they can be easily separated. The lac die and counter die thus formed will, if kept chilled, prove strong enough for the purpose of burnishing and swaging the pure gold cap to an accurate fit, and in the process of burnishing the pure gold cap may require to be annealed several times. As an alternative to a lac model, the impression may be cast in quick-setting plaster, and the model hardened. There are other methods, however, which may be employed. Proceed then to unite the cap to the band in the usual way. Next place the cap and band on the root and burnish once more, adjust the post or posts as described in the case of the first bicuspids and proceed to solder these together. It will be observed that owing to the position and angle of the post, where only one is used, the part which projects above the cap will not be in the centre, and this will apply also when more than one post is used. The method, however, whereby the central post which is to carry the crown is to be attached to the cap, will be dealt with later.

The lower central incisors. The manner of banding these is similar to that of the upper incisors; the exception to be noted with regard to the treatment of these roots is to guard against excessive reaming-out of their canals and thus avoid the risk of perforation. For this purpose the small special size of Peeso reamer previously spoken of is useful;

or the No. 12 right-angle Beutelrock's drill may be employed, and with a slow rotary motion in the direction in which the reamer is revolving, combined with an up-and-down motion, the canal may be safely enlarged to admit a suitable post.

The lower canines and bicuspids call for no special mention, as they may be treated precisely in the same way as the other single-rooted teeth.

Lower Molars. The lower molars present the difficulties associated with a multi-rooted tooth, in which, generally speaking, only one canal is suitable for anchorage. Fortunately, the posterior one generally admits of a fair-sized post, and when from any causes such as those mentioned in connection with upper molars the canal cannot be reamed out to receive a fairly long post, one of the canals in the anterior root can usually be counted upon to afford the necessary supplemental anchorage. If doubt should exist regarding the efficiency of the roots for this purpose, the pulp chamber may be so shaped as to afford additional anchorage, as already described. Here again, as in the case of the upper molars, the post does not project in a central position and while in certain cases it can be bent to a suitable angle for the purpose of carrying the crown, a separate post has usually to be added.

The Fitting of Bands for All-gold Crowns.

The all-gold or shell crown need only be referred to briefly, because the description already given regarding the making of bands and caps for tube crowns is applicable to the all-gold crown, with some slight modifications with regard to detail. The band

instead of being a narrow one must be of sufficient breadth to come almost in contact with the teeth in the opposite jaw when in occlusion. After the band has been fitted to conform accurately to the circumference of the tooth, the free end, which is to carry the gold cusps, can be contoured, or given such shape as may be necessary, without risk of altering the fit of the cervical portion, in the following manner: — Soften a piece of dental lac and press the fitted cervical end of the band into it, then thoroughly chill the lac and with pliers give such contour to the band as is required to conform it to the shape best suited to fill the space, which is usually that of the natural crown it is to replace.

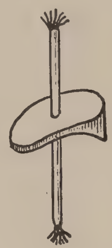


Fig. 98. Cap and Tube. Silk through tube to keep lumen clear while soldering.

Tube Posts instead of Solid Posts. When circumstances call for the application of a tube post instead of a solid one, the method whereby it is attached to the cap differs but slightly from that followed with regard to the latter, and consists merely in filling the lumen of the tube with some material which will prevent the solder from reaching its interior. This may be done satisfactorily by pulling through the tube a few strands of silk or cotton, or a spill of soft wood dipped first in rouge or whiting (Fig. 98). This should be done after the cap and post have been adjusted in the mouth and before the impression has been taken. With regard to any bending of the tube post which may be necessary in the process of adjustment, it is safer to fill the tube with some strands of thin copper or iron wire; thin binding

wire does well to fill the tube before bending it, as otherwise a "kink" may be formed in the tube post. After bending, the copper wire can easily be withdrawn.

Taking the Impression, Bite, etc.

There are various methods whereby an accurate impression may be obtained, and the selection of the most suitable one will depend upon the nature of the case. Generally speaking, plaster will yield the best results, and it is indispensable in certain cases. At the same time dental lac or modelling compound fulfils all necessary requirements in most cases, and saves time. While a model is nearly always essential, a bite in many cases may be dispensed with, particularly in the case of the front teeth. Where, however, a bite is employed, as it usually should be where the grinding teeth are concerned, the model need only be cast with a heel and not on a bite-frame. It is advisable to do the final shaping of the crown with regard to all its surfaces including the occlusal before finally fixing the crown on the root. Where plaster is used for taking the impression a tray may be employed in the usual way, or a quantity of plaster may be placed on a piece of thin paper and the mass carried to place and held by the fingers until the plaster sets. In order to remove the impression with the least amount of damage when there are undercuts, it should be deliberately broken by pulling the impression apart, when it will usually break in two or three pieces. The cap and post may come away in one of these, but should it fail to do so it can easily be replaced in the impression. If, however, there be any difficulty,

it can be removed by firmly grasping the end of the post with a pair of pliers, and applying a firm and steady force; without such precaution it may come away with a jerk and coming in contact with the adjacent teeth become damaged. When dental lac or modelling compound is used for taking a small impression and bite at the same time, the following method will be found to answer well:—Take a piece of either of these materials of suitable size, and after softening it press it into the space and around the adjoining teeth, when the patient should be instructed to close the jaw firmly until the teeth meet, and while the impression material is held against the buccal or labial surface the tongue should be pressed against the mass in the mouth. Before attempting to remove the impression and bite thus obtained, it should be thoroughly chilled with cold water, either by syringing or by means of a small sponge, and while this is being done the saliva ejector should be used, so that the water may be drawn off as quickly as it is applied. The most suitable plan to be adopted, however, will depend upon the nature of the case. For instance, if the case is at all extensive, involving say the six upper front roots, it is better to take an impression which will include all of them, as well as two or more teeth on each side, and at the same time a separate impression of the lower jaw, as these when mounted together on a suitable articulator give better results. Before proceeding to cast the model a thin layer of wax should be run around the inside of the bands to facilitate their subsequent removal from the model.

Having obtained the model and bite, the next step is to thicken up the cap (when it is made of pure

gold) with 20-carat solder. In order to do this the cap and post should be carefully removed from the model. To enable this to be done without danger of altering the relation between the cap and the post, the model should be hollowed out from its under surface in a line with the post or posts of the tooth or teeth to be crowned, until the end of the post is exposed. The cap and band should then be heated to soften the wax, and then by means of a blunt instrument be pushed upward, bringing the cap with it, and so removed without risk of the danger mentioned. The cap and post should now be invested with the smallest possible amount of investment which will enable the parts to be held together during the thickening-up process (Fig. 99.)

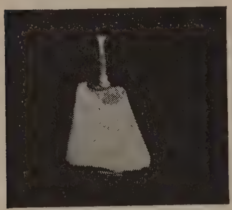


Fig. 99. Cap and post invested for soldering.

The thickening of the cap by means of solder may be quickly and satisfactorily carried out as follows: — Borax the surface of the cap and place on it three or four pieces of solder large enough to lie flat without overhanging. Heat up carefully in the usual way, so as to prevent the solder from jumping. After the borax has become fused, use the blowpipe with a large soft flame to heat the piece up, and flow the solder over the surface. When the soldering has been completed the piece may be plunged into cold water and the investment washed off. Next it should be boiled off in pickle to remove the borax. The cap should now be trimmed up with a fine file

Fig. 100. Post to carry crown re-adjusted.

or stone in the engine, care being taken to remove any superfluous solder which may have run up the post, and which would prevent the tooth from getting home without an undue amount of counter-sinking of the tube at the base of the crown — a matter of importance, especially where the crown is a fairly shallow one, as it is advisable not to weaken the porcelain more than is necessary.

If the tooth to be crowned is an incisor, the one post may do for anchorage in the root as well as for

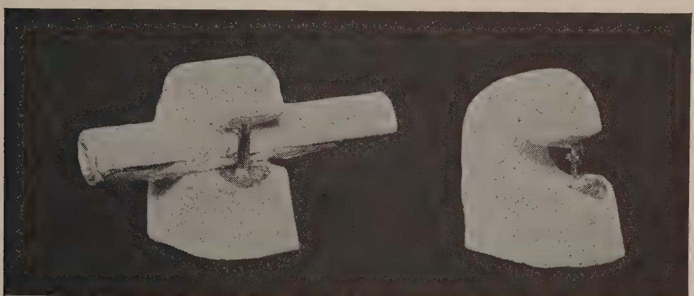


FIG. 101. Cap and post invested for soldering.

supporting the tooth, and if its position has not been accurately adjusted before the impression has been taken, this may now be done by means of the post-bender or a pair of pliers, the operator taking care to grasp the post close to the cap and to observe that the position of the cap is not altered. Such bending is almost invariably toward the lingual surface, and when considerable it results in unduly weakening the porcelain there, even if the post is brought to just behind the incisive edge of the tooth. A plan, however, whereby the maximum strength of porcelain may be obtained is to cut the post off close to the cap and readjust it more toward the labial sur-

face (Fig. 100). If, on the other hand, the tooth is a bicuspid, it is to be dealt with as already described, care being taken to have the post when possible in the centre of the cap. In the case of a molar, however, the procedure is as follows: — Drill a hole through the thickened cap and insert the end of the post into it. In order to keep the post in position, fix with sticky-wax, and as it is necessary during the process of soldering that the post be held securely, do this by investing as shown in Fig. 101, where it will be seen that a small arch of the investment material is employed, and this is formed by using a small roll of paper, which should be withdrawn after the investment has set. This may be thought to require a good deal of time, but experience has shown that only four minutes is necessary for the investing and for the investment to harden, while two minutes is sufficient for heating up and soldering. After the soldering is completed, the excess of solder is to be trimmed off and the tooth fitted in the manner to be described.

CHAPTER VIII

GRINDING MATERIALS AND APPLIANCES

BEFORE proceeding to consider the grinding wheels which are best suited for our needs, attention must be drawn to the fact that grinding wheels and their use has apparently attracted less attention on the part of our profession than any of the materials or processes with which we are familiar. This is all the more surprising when one considers the importance of the subject, and the continual use which we make of grinding wheels, discs, and points, in and out of the mouth. In the hope of arousing greater interest in this subject, and in order that a broader view of it may be taken in future, it is proposed to extend the matter beyond the confines of our special work. Had the enthusiasm of our profession been stimulated in this, as it has so often been in many matters of much less importance, the results would doubtless have long ago been apparent in better grinding wheels, and consequently of greater efficiency and economy.

That the various makes of grinding wheels for dental purposes fall below the standard which we look for is a matter of common knowledge and comment, but all of the causes which have led to this are not quite apparent. Lack of sufficient interest on our part does not altogether free the manufacturers and dealers from blame, but at the same time our indifference has probably resulted in the manu-

facturers and dealers misunderstanding our needs, and probably this is due at least in part to an unfortunate habit we have of speaking of wheels and other appliances as "no good" without informing the unfortunate makers why we think so. Whatever the causes may be, and some of these will be dealt with presently, our requirements are not met in the same complete way as are those of large users whose business calls for extreme accuracy in many of its branches, nor is this necessary. It will doubtless surprise many to know that grinding has now reached such a state of perfection, particularly within the last two or three years, that it has worked quite a revolution in engineering[1] and other trades, where specialisation has become a dominant feature, and threatens soon to extinguish the art of fine turning. As illustrating the degree of accuracy now reached, it may be mentioned that a grinding wheel of a hundredweight or more may be depended upon to grind to $\frac{1}{4000}$ of an inch, and at a surface speed of 6000 feet per minute. Such extreme accuracy is only possible, of course, when the wheel and machine are exactly suited to the work, and where the very heavy wheel head is rigidly supported from the floor in order to eliminate vibration. The specialisation spoken of has resulted in additions to the list of artificial abrasive materials, of which the well-known carborundum was the earliest, also to a great improvement in wheel making, particular attention being given to the grades and grits which are best suited to meet the growing requirements and rapid increase in the use of wheels for many purposes. Until quite recently grinding wheels were

[1] See "Engineering," January 29th, 1915.

used for a few metals only; now they are used to grind practically all metals, and are employed in grinding such materials as stone, marble, wood, bone, pearl, rubber, horn, bronze, etc. The selection of those wheels which are best suited to our purpose is a matter of the greatest importance. It will doubtless be urged, and with good reason, that while it is easy to criticise adversely the grinding wheels which meet nearly all our needs, it is only fair to the makers to state on what grounds the criticism of alleged deficiencies is based, and also to advance reasons in support of the belief that they could supply us with better wheels for use with the grinding lathe and engine than they do at present. Provided sufficiently good reasons are given, it appears not unfair to call upon the makers to provide us with wheels which will be free from the defects which might now be pointed out.

Abrasives may be divided into two groups — natural and artificial. To the former belong corundum, emery, and certain other natural abrasives less frequently used. Corundum and emery both consist of crystallized alumina (Al_2O_3) the oxide of the metal aluminium, along with varying proportions of lime, magnesia, oxide of iron and silica, which act as impurities, and the amount of the impurities in emery is greater than in corundum. As the relative efficiency is determined by the amount of crystalline aluminium oxide present, corundum is superior to emery, and the artificial abrasives are superior to both, but corundum and emery are tougher. The hardness of pure transparent corundum crystals is generally given as about 9, the diamond being reckoned as 10 on Moh's scale. There are, however,

differences in hardness between specimens from different localities. The amount of crystalline aluminium oxide in emery varies from 45 to 55 per cent in the best Naxos or Greek emery from the Island of Naxos. The purest corundum, which is mined in Eastern Ontario, Canada, sometimes contains over 90 per cent of crystalline alumina, and is the hardest natural abrasive. Neither emery nor corundum possess the qualities of sharpness or hardness, nor are they capable of being tempered in the same way as the artificial abrasives. The latter are most frequently used, are obtained by electric fusion at a very high temperature, and are purer than the natural abrasives. They may be divided into two groups, namely, the Carbide of Silicon (SiC) and the Oxide of Alumina, (Al_2O_3). To the former belong carborundum, crystolon, and carbosolite; to the latter alundum, aloxite, boro-carbone, carsilite, corindine, electro-rubies, and several like products. The principal materials used in the production of the carbide of silicon group are sand, coke, and sawdust, while the principal material used in the alundum group is bauxite, the purest form of aluminium oxide found in nature.

Carborundum. This is the trade name given to one of the pure forms of carbide of silicon (SiC), and its specific gravity is 3·17 to 3·21, whilst that of emery is 4. The principal materials used in the production of carborundum are coke, which supplies the carbon, and sand, which supplies the silicon. According to information furnished by the Carborundum Company "the raw material is placed in an electric furnace, and the current turned on. The furnaces used carry a current of 2000 electrical horse-

power each, and the furnace run is 36 hours. The total energy used in a single run of a Carborundum furnace is, therefore, 72,000 horse-power."

"The electrical current which is brought to the furnace by means of large copper bars, is obliged to pass through the furnace along a path of high resistance. The resistance thus interposed results in the generation of enormous quantities of heat, the temperature of the resistance path and the surrounding mass of coke and sand being raised to a point which is between 7000 and 7500 degrees Fahrenheit." Being the first of the artificial abrasives put upon the market, carborundum is probably for that reason the most widely known. Its manufacture was begun in 1891, and during the first year or more it was produced in such small quantity that it sold at tenpence per carat. In addition to possessing the properties of extreme hardness, sharpness and high-cutting quality, it is a non-conductor of electricity, has a low degree of expansion, high melting point, and high thermal conductivity. It is in consequence largely employed in refractory work for lining oil furnaces, welding furnaces, potters' kilns for various casting processes, and in many other ways.

Crystolon. Another form of carbide of silicon is a comparatively recent product turned out by the Norton Company, and is said to be most suitable for grinding and polishing materials of low tensile strength, such as porcelain, glass, marble, granite, etc., hence its probable superiority for our purpose. According to information furnished by the Norton Company, "Crystolon is carbide of silicon (SiC) in crystalline formation. It is an electric furnace prod-

uct made from coke, sand, sawdust and salt. These materials are carefully and accurately mixed, and heated in furnaces to a temperature of between 1820 and 2250 degrees Centigrade. Each charge in the electric furnace consumes about 1000 H. P. When sand and coke are mixed together with the proper proportions, and heated to a sufficient temperature, they combine to form carbide of silicon. The quality of carbide of silicon depends largely on the materials used, the skill with which the furnaces are set up, the skill used in making the mixture, and in the operation of the electric furnace."

Alundum, aloxite, borocarbone, and other artificial abrasives belonging to the aluminium group are all pure forms of Al_2O_3, and differ from one another only in name and in differences in treatment during the manufacturing process. They are mostly formed from a mixture of bauxite and coke, the latter proportioned to reduce the oxides of silicon and iron, and to leave the nearly pure oxide of alumina crystals.

Bauxite is the purest form of aluminium oxide found in nature, and occurs as a soft clay-like substance, and is similar to the ruby and sapphire in chemical composition. It was originally discovered in France, in the Southern parts of which are found the richest and best deposits in the world. It is also found in the Southern parts of the United States. The ore, after it is mined, is washed to free it from impurities, such as sand. It is then dried and forwarded to the works, where it is calcined in a rotary furnace or kiln, in order to drive off the water which is chemically combined with it, and after proper mixture is conveyed to the electric furnace and fused. Until the invention of the special form of electric arc

furnace, this was considered infusible. Fusion which takes place at about 3800 Fahrenheit, or 2100 Centigrade, leaves its chemical composition unchanged, but completely transforms its physical character into a crystalline mass, which, after cooling, is ready to be crushed into various sizes of grains. It is specially adapted for cutting materials of high tensile strength, such as the various steels.

From the statements made by the manufacturers of these artificial abrasives, and by experience gained in their use, it is apparent that the carbide of silicon group, represented chiefly by carborundum and crystolon (SiC), are superior to the oxide of alumina group (Al_2O_3), represented chiefly by alundum and aloxite for cutting materials of low tensile strength, such as cast iron, granite, marble, etc. The hardness of these abrasive materials averages about 9·5.

The treatment of these various abrasive bodies after fusion is similar. The crystalline mass is broken up, crushed, and then graded into various sizes, about forty being marketed. These range from 10 to the finest possible dust or flours, and the following sizes of grits, or, as they are often spoken of by some makers, grains, are listed by some of the best-known makers: — 10, 12, 14, 16, 20, 24, 30, 36, 45, 60, 70, 80, 90, 120, 150, 180, 200, F, FF, FFF, FFFF, XF, 65F, and 65C. These last seven are known as flours, and are mostly used for hones or sharpening stones, and for rubbing or polishing.

Grit. The suitability of wheels for special purposes mainly depends upon two essential factors, grit and grade, and these terms are well worth understanding. Grit, or as it is sometimes called "grain," is the term employed in reference to the

individual particles or grains of these abrasives. Thus, by No. 20 grit is meant a size that will pass through a grading sieve having 20 meshes to the linear inch, but which would not pass through a mesh of 30 or 40 to the inch. The term, therefore, denotes the fineness of the wheel. The greatest importance is usually attached to the matter of hardness in abrasives, and this has been made the most of by makers of grinding wheels. While hardness is essential, its importance has been overdone, in consequence less attention has been directed to the matter of "temper" which has been given a less prominent part than its importance warrants. Temper means the strength of grit, and the character of its fracture or wear under grinding pressure. The grit should be hard enough to stand until its cutting point becomes dulled, and when it breaks it should break with a sharp fracture and present a new clean cutting edge. The character of the fracture depends upon the physical formation of the grain. The highest degree of efficiency cannot be obtained by developing hardness or temper alone, but only by the proper combination of both. During the process of manufacture varying degrees of hardness, sharpness, and toughness of grain may be obtained by controlling the rate of cooling. Therefore wheels may be made of grains tempered to suit different classes of grinding.

The term *grade* refers to the degree of hardness of a wheel or resistance of its cutting particles under grinding pressure. When the cutting particles are easily broken away from the bond, the wheel is said to be soft. Such a wheel cuts rapidly, but wears away fast. A wheel which retains its particles

longer is called hard, and when too hard it heats the work, glazes, and will not cut. These distinguishing characteristics of grade and grit, combined with the property of tempering already spoken of, permit of variations in wheel-making to suit every class of grinding, and that the matter of grade is of great importance in connection with grinding wheels for trade purposes is shewn by the fact that wheels made with vitrified or silicate bond are listed in some wheel catalogues in at least two dozen grades or degrees of hardness which are usually indicated by a letter of the alphabet. Some makers begin their series from "C" very hard, to "Z" very soft, while others reverse this order and begin "H" very soft, to "Z" very hard. Whichever plan of lettering is adopted the standard of hardness to which it refers is purely an arbitrary one, and, of course, only known to the makers. This it will be seen later adds greatly to the difficulty in making practical suggestions with regard to a series of wheels better suited to our needs.

The plan usually followed in connection with a "Grade Scale" is to divide it thus, into "Very hard," "Hard," "Medium Hard," "Medium," "Medium soft," "Soft," "Very soft," and "Very very soft." "Medium hard" and "Medium soft" alone account for ten grades. It is apparent, therefore, that the makers are alive to the requirements of the various trades, and are ready to meet the rapidly increasing demands for wheels for all ordinary purposes. This they can readily do by their ability to vary the grit and temper of the abrasives employed, as well as the nature and composition of the bond. It is mainly in this latter respect, as previously men-

tioned, that dental wheels fail to meet our needs. The wheels with which we are supplied are usually listed by the dealers as coarse, medium, and fine, or as follows: — (A) Extra extra coarse; (B) Extra coarse; (C) Coarse; (D) Medium; (F) Fine. Sometimes the grit number is added, but very rarely; thus, (A) Extra extra coarse equals 80, and so on through the grades to (F) Fine equals 220. No reference is made to the all-important matter of grade, nor is the nature of the bond given except where vulcanite is used, and it is unfortunate that the system adopted for wheels for trade purposes has not been followed in the case of dental ones. At present some kind of system is followed, and the letters, A, B, C, D, and F, are supposed to stand for both grade and grit — "that is, a wheel in A Grade will be, generally speaking, both coarser and softer than a wheel in F — in short, usually the finer the grit the harder the wheel."[1] No more definite information appears to be available, and while we have hitherto failed to make our requirements known, we have reason to feel dissatisfied that our attention has not hitherto been drawn to the outstanding importance of grade as well as grit. Therefore, as matters stand at present with us, the selection of a wheel to match one which has been found specially suited to a particular class of work becomes a matter of mere guess-work, and has usually, indeed one might say always, to be decided upon the mere surface appearance of the wheel. Men of experience usually find little difficulty in arriving at a close approximation to it as far as grit is concerned, but in the matter of grade it is entirely

[1] Quotation from a letter from a firm of wheel manufacturers.

different, and one is generally compelled to rely upon the similarity in colour only, a most uncertain and unreliable guide. At the same time, an important advance would be made if the suggestions spoken of were followed out, and grinding wheels for dental purposes were standardized in the same systematic manner as they are for commercial purposes.

Grinding Wheel Bonds. The term "bond" is used to describe the material which is used to hold the grains of abrasive material together. Three of the principal bonds in the order of their importance for ordinary trade purposes are:—vitrified, silicate, and elastic; and it is to be noted that the grade or degree of hardness of a wheel depends largely on the formula of binding material used, and on its treatment.

Most of the well-known makers of wheels draw special attention to the vitrified and silicate bonds, particularly the former, for which they claim superiority over other forms of bond for nearly all purposes, and one of the special claims made in their favour is that these bonds are themselves fairly good abrasives. Possibly these claims are well-founded when the matter is looked at from the point of view of all-round usefulness, and simplicity of manufacture; but they do not hold good in the case of wheels for grinding porcelain, or similar materials. For these a vitrified or silicate bond is far inferior to a suitable elastic one, in every respect, and the contrast is most marked in the absence of any tendency to chipping or fracture of fine edges in the case of elastic bonds which possess other outstanding advantages to be dealt with later.

The carbide of silicon compounds, such as car-

borundum and crystolon, are not made in silicate bonds, as the grains will not bind satisfactorily with silicates, and these materials are only suited for use with vitrified and elastic bonds, whereas alundum, aloxite and similar oxides of alumina can be made in all classes of bond. The exact composition and the proportion of the various ingredients used in connection with these bonds are jealously guarded trade secrets, and can only be described in a general way.

The Vitrified Process. As vitrified wheels are far more extensively used than either silicate or elastic bond wheels, a short description of some of the principal points in connection with the manufacture of an alundum wheel will serve to convey a general idea of the process of wheel making. The bond of these wheels is composed of felspar, which is a double silicate of aluminium and potassium, and is represented by the formula Al_2O_3, K_2O, 6 SiO_2, along with kaolin, and probably other materials. In fact, the composition of the bond is very similar to that of common porcelain. The kaolin, which is the principal element in strengthening the bond, is rendered fusible by the addition of the felspar. Variations in the amount and composition of the bond are mainly relied upon to produce the desired grade. The abrasive grains along with the required amount of bond are mixed together in the dry or powdery state, and when the charge is thoroughly mixed, water is added, the quantity being carefully gauged as the properties of the wheel can be materially altered by adding too much or too little. The mixture, usually of the consistency of thickish paint, is poured into suitable moulds, which are then slowly

air-dried to prevent the formation of cracks, and are further dried in heated rooms preparatory to being turned to shape and fired in the kiln. A modification of the foregoing process is employed where very hard close-bodied vitrified wheels are desired. The rough-moulded wheels are turned and trued to the required size, allowance being made for shrinkage in firing.

The firing is a very important part of the process, as the temperature must be evenly distributed over the whole kiln, and controlled for a long period. The kiln is similar to that used for firing porcelain or pottery ware, and the wheels undergo almost precisely the same treatment, being protected from the direct action of the flames and gases by packing them in seggers. The firing process lasts from three to five days, and the cooling process for a week or longer, the object of slow cooling being to obtain the benefit of the maximum amount of toughness which can only be got in this way. This point is well worth noting in connection with firing porcelain teeth, which in these days suffer by comparison with those of former times, for the reason that slow cooling now receives far less attention than formerly. After the wheels have been fired and cooled, they are trued in a lathe, the sides being first done, and afterwards the periphery, and for this purpose a revolving type of disc truing tool is used. This is held in a suitable rest, and is fed in against the wheel. For the smaller size of wheels a diamond truer is used. The wheels are next bushed to the bore required, and are then tested for balance, and lastly they undergo the all-important speed test, every precaution being taken to ensure that they are perfectly safe to oper-

ate with. The speed for this test is at least 60 per cent faster than the usual speed, but this latter test is only applied to wheels over five inches in diameter.

The Silicate Bond. This is obtained by employing a silicate of soda or water-glass mixed with the abrasive grains, and sometimes other materials, the plastic mass being tamped into suitable iron moulds, and afterwards baked in a similar manner to the vitrified wheels, but at a much lower temperature. Soluble glass is formed by fusing silicate, flint, or sand, with an excess of alkali, soda or potash. The glass thus formed is slowly soluble in cold water, but readily soluble in hot water if powdered. The larger the quantity of alkali the more soluble it is. These wheels are said to be less free cutting in the harder grades than are vitrified wheels of the same grade. The silicate bond is a closer bond than the vitrified one, and so these wheels are 20 per cent heavier, in fact about the same weight as emery wheels. On account of the comparatively low degree of heat required, these wheels can be made with a wire web. All wheels above 30 inches in diameter are made by this process, and they can be much more quickly made than by the vitrified process. Both these bonds are so hard that they are abrasives, and assist slightly in cutting. They are unaffected by acids, heat, or cold.

The Shellac or Elastic Bond. This is composed principally of shellac, but these elastic wheels are also bonded by various gums, resins, rubber, and linseed oil. These permit of a great variety of grades being obtained. The special advantage derived from the use of these bases is diminished

danger of breakage from shock or irregular pressure. In consequence, wheels made by this process possess a high degree of safety, and may be made very thin, and while it might not appear so, they are truer running under ordinary working conditions than wheels of other bonds. The bond is not harsh, but elastic and resilient, making the wheel eminently suitable for grinding porcelain edges, glass, or similar friable substances, in fact they have some valuable qualities which are not attainable in other wheels. They will resist a considerable amount of side pressure, and will easily withstand an amount of centrifugal strain that would burst ordinary wheels.

Superior though the now almost obsolete shellac base wheel was to the vitrified one, as far as bond was concerned, it is possible to improve greatly on the original pure shellac base by the addition of other resins, oils, etc., and so a nearly unlimited number of bonds may be had which are specially adapted for use in grinding materials of low tensile strength. Elastic bond wheels are made as fine as $\frac{1}{32}$ of an inch in thickness up to 4 inches in diameter, $\frac{1}{16}$ of an inch up to 8 inches in diameter, and $\frac{1}{8}$ of an inch up to 12 inches in diameter. They are specially adapted for grinding between the teeth of gears, for grinding chilled steel rolls where a high finish is required, and for putting a fine surface on marble. Some of the principal makers of wheels supply about a dozen grades of shellac base in 25 grits.

Other forms of elastic bond are frequently used, and for our special purposes vulcanite is now the most common. Familiar examples are the well-known S. S. W. Vulcarbo discs and points, and Leam-

ing's Vulcan wheels, discs and points. With regard to elastic or shellac wheels, they are made in moulds, and are formed under heavy pressure, after which they are baked in specially constructed ovens in a similar manner to silicate wheels, but at a low temperature, and, as already said, these wheels are specially suited, owing to their elasticity and resilience, to work requiring a fine finish.

General remarks. There are some points well worth mentioning in connection with grinding wheels and their use, and while these will have special reference to our work, they will also include some observations which are applicable to grinding practice in general. The complaints one so frequently hears made about grinding wheels having "soft spots," are due to wheels running out of truth, or out of balance. Vibration, due to lack of steadiness either of the grinding machine or of the work, or of both, is by far the most common cause, particularly in dental work, and some of the reasons for this are obvious. The principal one is that it is impossible to hold a porcelain tooth or like object steadily against a rapidly revolving surface, as oscillatory movements are set up owing to the resilience of the fingers, and so irregular pressure is brought to bear on the wheel, with the result that uneven wear is set up, which being rapidly cumulative in its effects, causes the wheel to run far more quickly out of truth, than where a rigid mechanical rest is employed. In order to find out if a wheel has "soft spots" it should be marked where the "soft spot" is supposed to be. The wheel should then be trued and used to grind with once more, when it will usually be found that the "soft spot" has moved to

another point on the wheel, showing that it is out of balance. In the case of wheels and points used for the dental engine, the extra vibration resulting from the lack of weight in the body of the handpiece, is added to the cause already spoken of, and also makes the wheel wear faster. Grinding wheels generally appear to become softer, and wear away more rapidly as they become smaller, that is, they appear to become softer towards the centre. One reason for this is that the particles or grains of abrasive material have to do more work as the wheel becomes reduced in diameter, and so it naturally wears faster. In ordinary engineering, or similar practice, the rate of wear is made good by increasing the speed of the wheel as it wears down. This is done either by employing a coned pulley, or by transferring the wheel to another grinder in order to maintain as nearly as possible the same peripheral speed.

Speed. The speed at which wheels are run in connection with various industrial operations varies greatly, and may be said to range between 4000 feet and 6000 feet per minute, although in some instances it is higher. For our purposes, however, such speeds are not called for, neither are our grinding lathes adapted to them, the variations provided being usually in four stages, from about 1200 to 3500 revolutions per minute. In practice the lowest of these speeds, 1200 per minute, is sufficiently fast for grinding porcelain, although the high speeds may be useful for smoothing and polishing. The question of surface speed is one which seems hitherto to have escaped attention in connection with our work, although in ordinary grinding practice it is considered of the highest importance, and a few words of expla-

nation may prove useful. Surface speed means the distance travelled by a point on the surface of the wheel in a given time, and is usually described in numbers of feet per minute. Its importance in relation to rapid cutting will be obvious when it is remembered that a 4-inch wheel travels the distance of about 1200 feet per minute on the lowest speed, while on the highest speed it gives about 3500 feet per minute; so that disregarding the question of grit and grade, it will be obvious that the higher speed permits of more rapid cutting, but ordinarily for our purposes the rate of cutting should be made to depend more upon the grade and grit of the wheel used, rather than on increase in speed. A wheel, if run at excessive speed, will appear too hard, heat the work, glaze, and refuse to cut, while the same wheel if run at a very slow speed may appear too soft. Hard-cutting wheels should not be used because they last longer; a fast-cutting wheel is the most economical in the end, even if it does wear more rapidly, because the output of work determines economy. Avoid excessive pressure against a wheel, as this does not produce more rapid cutting but only friction, heat, and clogging of the wheel. Increase in the speed of a grinding wheel gives the effect of a harder wheel; decrease in the speed gives the effect of a softer wheel. If the surface to be ground is a broad one, a soft wheel should be used, but if the contact is merely a point one, then a harder wheel must be employed. An apparent anomaly exists with regard to the grade of wheels used for certain purposes. For instance soft wheels should be used on hard material, such as hardened steel, while on softer materials such as wrought iron, mild steel, etc.,

a harder grade should be employed. The explanation is that in grinding a hard material the grains dull more rapidly, in consequence a fresh cutting surface must be oftener presented. In other words, the grains must be removed as soon as they become dulled. In the case of a soft material, the cutting grains last longer, and so do not require such frequent renewal. A successful grinding wheel possesses a characteristic peculiar to itself, — that is the power of sharpening itself while at work, for the reason that the grains on the surface of the wheel as they become dulled, broken, and forced out under the stress of work, continually expose new cutting points. In consequence a wheel is most efficient when it is soft enough to cut freely, but does not wear too rapidly and yet is not hard enough to glaze.

Truing wheels. Wheels should always be kept trued, and should be trued whenever they are out of truth. The importance of this does not appear to be generally realised, but if speed and accuracy are to be obtained, it must be kept in view. A wheel that is out of truth does not cut on its entire periphery, and the defect may be so marked that a large percentage of its cutting power is lost. Work should never be begun with a new wheel until it is certain that it runs true.

There is a number of appliances on the market suitable for truing and dressing wheels. Probably the most useful all-round truer is the diamond, and for industrial purposes the black carbon, Cape Ballas, and Bortz are best. Large wheels require large-sized diamonds for the reason that the excessive vibration set up when a wheel is out of truth is so great that the stone is apt to be disturbed in its

setting. It is always more economical to true a wheel when it is slightly out of truth than to leave it until it is too bad for grinding, because by so doing there is less shock to the diamond. Better results are to be got when the truer is held rigidly in a rest before passing it across the surface of the wheel, but for truing small lathe wheels such as we

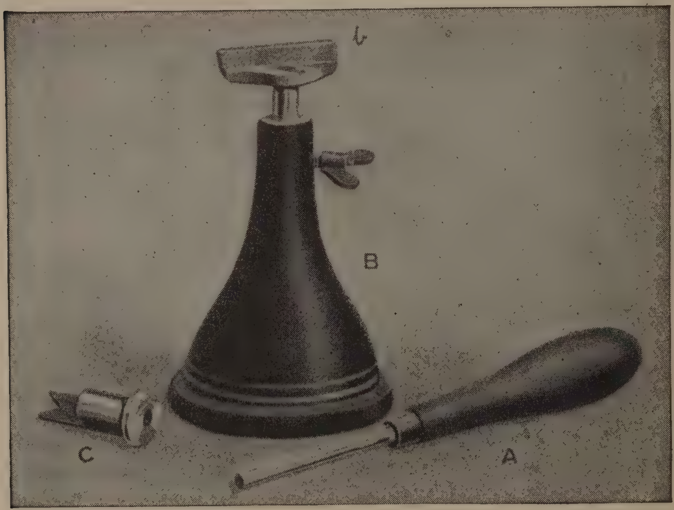


FIG. 102. A, Black Diamond, Steel Holder and Wooden Handle. B, Adjustable Tee-Rest. C, Attachment for use in conjunction with Tool A.

use, a hand-truer, similar to that shown in Fig. 102 is all that is necessary. In these truers the stone is first embedded in copper or soft brass, and the steel holder closed firmly over it. An abundant flow of water should be used to keep the diamond cool, and avoid disintegration, and great care should be observed not to grind away the metal surrounding the stone. Other forms of grinding-wheel dressers, such as "Desmons," "Diamo-Carbo," the "Huntington" and the "Metcalfe" are excellent, but more par-

ticularly for the largest sizes of dental and other wheels.

Reverting once more to the question of the best wheels for dental purposes, it may be remarked at the outset that it is impossible to state with any degree of accuracy the various grades and grits of wheels which would be an improvement on those at present supplied by the leading makers, nor does it appear necessary that this need be attempted. Some of the reasons why it would be impossible to state precisely what would best meet our requirements have been already given, and many may think them sufficient, but in order to make them more convincing, attention is directed to the fact that it would involve specifying the most suitable grits and grades, as well as bonds. Obviously, it would be impossible to do this, even if one referred to the Catalogue of any single maker, because the grade (degree of hardness of bond) as already stated, is determined by an arbitrary standard fixed by the maker.

The matter of grit (degree of coarseness of the individual grains) would appear to offer no difficulty because the size of the abrasive grains is a known quantity, and is determined by measurement, but even here we might be faced by another difficulty, because the makers state that the cutting properties of the grains, can be, and are, modified to suit different materials, and the nature of such modification is not stated for any particular material. There is next the question of the bond or base used to bind the grains together. Here another difficulty is apparent, because its exact composition is a trade secret, but we know from makers' catalogues that

the bond can be treated in a manner to yield 25 or more grades or degrees of hardness, both in the vitrified and silicate bonds, while, in addition there are about a dozen elastic bonds. These then, are some of the difficulties which preclude the possibility of arriving at a standard except with their co-operation. We know that wheel makers already have experience in making elastic bond wheels for various trade purposes and being thus provided it should not be difficult to induce them to supply our

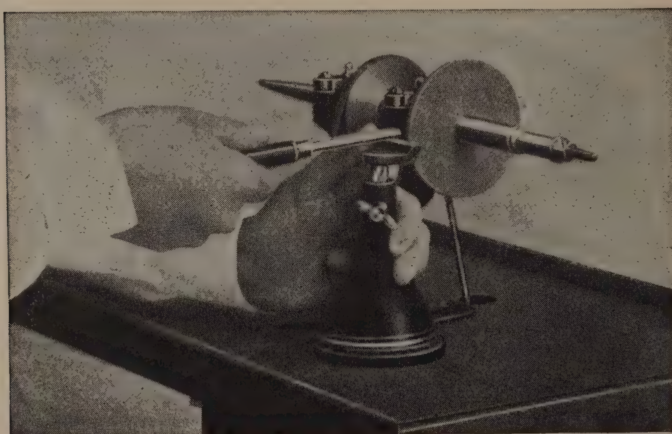


FIG. 103. Shows method of using Diamond Truer.

needs once their attention has been directed to them. These would probably be met by providing us with a standardized set of wheels in a few grades of grits. It is open, of course, to the makers to maintain that no better grinding wheels can be made than those we have at present, and that we would derive no benefit from standardization, or by the substitution of an elastic bond in place of a vitrified one. It is not proposed to enter into

an elaborate description of the tests which were employed in order to arrive at the conclusions which will presently be stated. It was realised at the outset, however, that the only satisfactory way of obtaining a correct basis was to have the necessary tests carried out by men of sound and extensive practical experience. These the writer found in his partners and his mechanics. Other men, of equal experience, also assisted, but their help, while very valuable, was less constant. The tests made were very numerous, and extended over a long period, and they were carried out mainly on the lines of every-day practice. Many of the tests were made, compared, and checked together.

The materials used for carrying out the tests consisted of an extensive collection of the dental wheels by the best known makers, also wheels selected from the ordinary wheel trade catalogues, and other special wheels. The abrasive materials of which these were composed comprised carborundum, carbosolite, crystolon, aloxite, and alundum. The carbide of silicon group (SiC) represented mainly by carborundum, crystolon, etc., were proved to be superior to the oxide of alumina (Al_2O_3) group represented chiefly by alundum and aloxite, and this was in accordance with the opinion expressed by the makers who favour the former group (carbide of silicon) for materials of low tensile strength such as glass, marble, pearl, porcelain, cast iron, chilled iron, and brass. The grit and grade of wheels tested other than the dental ones, for which there is no definite standard, were those listed in the trade catalogues as most suitable for cutting porcelain, glass, and like materials. The materials upon which

the wheels were tested consisted of the plain and vulcanite teeth, of most of the best-known makers, also tube teeth old and modern, old time gum teeth and sections, porcelain tube rods, fused porcelain, inlay porcelain, glass, and natural teeth. The various wheels were matched as nearly as their diverse standards permitted, and as far as could be in accordance with the recommendations furnished by the various makers of those wheels which are best suited for grinding porcelain and like materials.

FIG. 104. Diamond Truer with Attachment "C" used for engine wheels.

Various wheels were also tested on metals for which they were listed as suitable.

Special attention was given to the rate of cutting, the finish produced, the amount of wear in proportion to the work done, and to the results obtained in grinding thin frail edges. Other qualities were taken into account such as true running, amount of vibration and heating. These latter were particularly noted in connection with grinding teeth in the mouth in which these factors count for far more than they do outside the mouth. As a result of these tests and after fully considering

the manner in which our needs would best be met in the matter of grinding wheels, discs, points, etc., the following conclusions were arrived at; (1) That all wheels for dental purposes should have grade and grit either stamped on them, on the shank in the case of engine points, etc., or they should be vended in such a way that no doubt should exist with regard to their character, in short, that dental wheels, etc., should be listed and sold on the same plan as that followed in wheel trade catalogues; (2) That the elastic or shellac bond is a far better bond than the vitrified one and that wheels can be made in this bond as hard as, or harder than required for our purpose, capable of faster cutting, and with no tendency to chip fine glasslike edges, and much less tendency to heat; also having as good, possibly better, lasting qualities, much more pleasant to use with the lathe, and far less disagreeable to the patient when used in the mouth.

There seems no room to doubt that a great mistake was made in abandoning the shellac bond for the vitrified one, more especially when we know that the makers can modify the shellac bond by admixture of various other bodies so that they can produce wheels suited to grind most materials to the best advantage; and the fact that about 12 grades (degrees of hardness of shellac bond) are listed, and the various uses for which they claim they are best suited, is evidence of this. The tests spoken of furnished abundant proof that a shellac bond (sometimes called "elastic bond") wheel which most nearly approximates that of a similar vitrified one of like grit and grade, affords a wheel which is faster cutting, gives a better and finer finish, and is

truer running under similar conditions; and that this is most strongly marked when elastic base wheels are used for grinding certain materials in which the feed must be by hand, in natural as well as in porcelain teeth, etc.

CHAPTER IX

GRINDING MATERIALS AND APPLIANCES (*continued*)

THE consideration which has so far been given to the subject of grinding wheels has been directed mainly to those for use with the grinding lathe, but the elastic base wheels are of even greater importance for use with the dental engine in the mouth, when they are used for grinding or polishing living teeth, or in connection with grinding fillings. This is due to diminished vibration, friction and heat, and so it follows naturally that the liability to cause pain is greatly lessened. It is unnecessary to dwell at length upon these points, but it may be said that diminished vibration alone counts for a great deal, for the reason that to many patients vibration appears to be less easily borne than even a moderate amount of pain. As reduced friction means less heat and pain, the results obtained by the reduction of those undesirable accompaniments can hardly be over-estimated. That they can be obtained has been amply proved by practical experience, and so the arguments which were employed with regard to the advantage to be derived from the adoption of a system of properly graded elastic base wheels for general dental purposes also apply when they are used in the mouth.

There are still other advantages which call for notice and which are apparent in connection with their use both in and out of the mouth. These are

most noticeable in regard to the employment of thin cup-shaped and other forms of discs and points which are capable of standing a far greater amount of side pressure than are vitrified ones of like kind. Moreover, they maintain a better edge, and are not nearly so liable to run out of truth when subjected to the shocks incident to our methods of using them, as already explained in speaking of the effects of oscillatory movements in connection with hand feed. Were further evidence necessary regarding the superiority of the elastic base for withstanding side pressure it could be found in the catalogues of the various wheel makers who draw particular attention to this feature of the elastic base.

There is also, of course, the question of economy which affords an additional and very practical argument in favour of the elastic base, as those whose work has led them to rely on the use of thin discs have good cause to know how little any of the forms of vitrified discs are to be relied on, and how high the percentage of breakages is, also the small amount of wear which is to be got out of them for the other reasons given.

Vulcanite Base Discs. In dealing with the subject of elastic base, the shellac process is the one which has been referred to, and it has been seen that in this process, while shellac is mainly used (sometimes entirely) other materials such as oils, resins, gums, etc., are frequently combined with it, in order to obtain bonds suited to special needs. At the same time it must be borne in mind that vulcanite, celluloid, and other materials, are also used as bonds, either alone, or combined with other substances, to form a base for wheels, etc., for dental and other

purposes, and so we have the well-known vulcarbo wheel discs and points of various well-known makers such as the S. S. W. Co., the Carborundum Co., and Leamings. Unfortunately, they are usually made in one grit, or at most two. At the same time, they are invaluable for many purposes for which the vitrified ones are entirely unsuited, and some of these thin forms of vulcarbo discs are even better than those of thin shellac bond. In consequence, they are to be looked upon as indispensable for some operations, and their place so far has not been efficiently filled by any other form of elastic base. Certain forms of natural stones have been and are sometimes used for the purpose of cutting and smoothing porcelain and producing a dull polish, but it is mainly in connection with smoothing and polishing that they are employed in our work. These comprise Arkansas, Hindostan, Water of Ayr, and other special stones, but some of these will receive attention later.

Diamond Discs and Reamers. These possess advantages for certain operations and the discs are mainly useful for cutting thin grooves such as in porcelain inlays, or where an extremely thin cut requires to be made between teeth. They are made of copper or soft iron, the latter having less tendency to bur on the edge, charged with diamond powder, and must always be run wet and must not be pressed to the work but allowed to feed themselves, otherwise they chatter and jerk, and so become useless. Diamond reamers are useful for various purposes in connection with prosthetic and operative work and are used mainly for occasionally enlarging the tube of tube teeth or porcelain rods for the purpose of

permitting a heavier post or bar to be used where extra strength is required. Fig. 105 shows a set of four with extra long shanks which allow of their use for all purposes connected with tube work, and for other purposes.

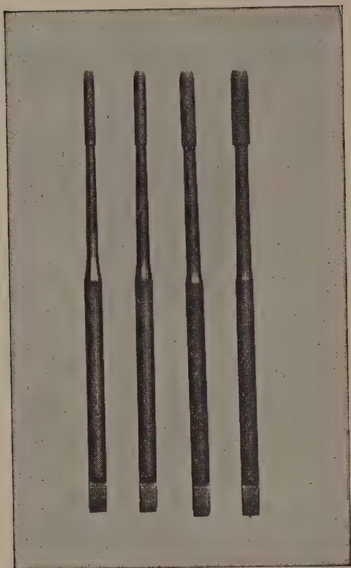


Fig. 105. Special Diamond Reamers suitable for Tube work.

Brass, Copper and other Kinds of Metal Wheels and Discs used in connection with Grinding and Polishing

It will often be seen that where the broken down particles of a grinding wheel and the débris from the substance ground are permitted to accumulate, as for instance, where a piece of sponge becomes so charged, the wheel begins to wear rapidly, while at the same time the substance which is being ground acquires a more even and velvety surface. This is due to a double rotary, doubtless gyroscopic action being imparted to the individual grains of the grinding material which have become detached from the wheel, and these not only help to grind or wear away the wheel itself, but they also impart the peculiar mat-like, and often very desirable surface referred to, and this may also be obtained by the addition of a quantity of abrasive powder of which the wheel is composed, to the water, sugar solution, or whatever fluid is employed for wetting the wheel. The

recognition of this fact led the writer to the use of metal wheels and discs along with abrasive powders and sugar solution for the purpose of cutting porcelain, and the results obtained in this way surpassed expectations.

Cutting off sections from porcelain rods. When carborundum discs are used for making deep narrow cuts as for instance where a section of tube rod has to be cut off, they have two serious drawbacks: first, they are very liable to jamb and so break. This is not surprising when one remembers that these wheels are thick in the centre and tapered toward the edge. It follows then from their shape that the deeper the cut the greater the amount of friction on the sides of the wheel. Second, they are liable to run out of truth. Elastic base wheels would lessen the tendencies referred to, and for industrial purposes they are employed with most satisfactory results under conditions similar to those described, but at present similar wheels are not procurable for our purpose.

An efficient substitute, however, is found in soft brass or copper discs, 18–24 U. S. Gauge, and one about 4 inches in diameter, used with fine carborundum powder or similar artificial abrasive, grit 220. The cutting agent should be added to a solution of sugar in water, applied by means of a sponge in the same manner as water for keeping wheels wet while grinding. A very brief trial will suffice to determine the strength of the sugar solution, and the amount of abrasive powder necessary. Instead of sugar solution oil, vaseline, or glycerine may be used, but experience has demonstrated that sugar solution is best because it seems to gum the particles

of the abrasive better to the edge of the disc than any of the other lubricants spoken of, and moreover it washes off readily from the specimen and from the fingers, which the others soil badly. In cutting porcelain in this way, it should only be lightly pressed to the work, otherwise the disc will glaze on its edge and not cut. A disc only about half the thickness of the required cut should be used, as the disc cuts on both sides as well as on its cutting edge. (Figs. 106 and 107.)

Fig. 106. Showing cut made through S. S. W. No. 10 Molar Tooth. Time taken 30 sec., using brass disc and Carborundum powder, No. 220 with sugar solution.

Metal Wheels for grinding. Instead of ordinary abrasive wheels for grinding, soft brass or copper wheels may be used with advantage in many cases for the same purpose, and they should be supplied with sugar solution and carborundum, or similar abrasive powder, grit 220 as described in connection with metal discs. Grit 220 will be found to cut faster and afford a better surface for subsequent smoothing and polishing than coarser powders, but F. gives a finer surface and cuts nearly as fast. The rate of cutting is increased by the coarseness of the powder — provided it does not exceed 120 grit — and the quantities of powder and sugar solution used. The free particles of the abrasive appear to behave in a manner somewhat similar to that already suggested in connection with the accumulated

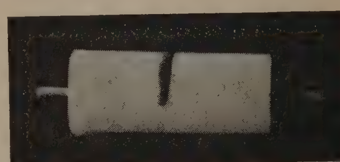


Fig. 107. Cut made in porcelain rod No. 25, with a brass disc, using Columbia lathe at lowest speed with carborundum powder and sugar solution. Time taken, 45 sec.

débris from an ordinary wheel. Metal discs, wheels and points similar to those described but for use with the dental engine will be found useful for shaping up porcelain crowns, bridges, and in connection with the shaping up of cavity margins, and finishing fillings, indeed for all the purposes for which carborundum, vulcarbo, diamond, and other kinds of discs, etc., are used.

Methods of keeping lathe wheel wet while grinding. It is usually claimed for the artificial dental abrasive wheels that they cut as fast dry as they do wet, and that they are not liable to glaze. These claims are true only to a limited extent, and are apt to be very misleading. Under normal grinding conditions, water and plenty of it is a decided aid to rapid and efficient cutting, and prevents heating, glazing, danger of cracking the tooth, and trouble from dust. The problem, therefore, of keeping wheels sufficiently wet, and yet not so wet as to cause excessive sparking is not so simple as it looks, especially when the wheel is run at a high rate of speed. With the old style of foot-driven lathe, there was little difficulty, as the wheel could be run in a trough of water without much risk of sparking, or the old-fashioned device of a sponge held by the fingers, or a sponge-holder, did quite well, and does so still, only there are the disadvantages associated with holding the sponge and excessive wetting of the fingers. There are several devices which do much to minimise these drawbacks, and these will be found a marked improvement, both as regards uniformity in the supply of water, and also in overcoming the objections which result from the holding of the sponge with the fingers, and the appliance shown in Fig. 108 will be

found both efficient and simple. The point of chief importance is to keep the wheels wet. In place of water other lubricants such as oil, vaseline, etc., may be used with advantage in some cases, but water is the only lubricant which should be used with wheels of which the elastic base is mainly composed of shellac.

FIG. 108. Simple appliance to keep wheel wet and also to prevent splashing.

The Grinding Lathe. This should, for choice, be one of the well-known electric ones, such as the Columbia, made by the Ritter Dental Manufacturing Company, or the S. S. White Grinding Lathe. Both are admirably suited to our purpose, except in the matter of chucks, and the objections which will be stated against them are applicable to all chucks provided by the various makers of dental chucks for wheel mounting. The chucks themselves are badly suited to the purpose for which they are intended, and are a contributory cause to wheels running out of truth. Their chief defect arises from a deficiency with regard to the size of flange on both sides of the wheel, particularly in the case of the larger wheels. This results in an unnecessary strain being put on the centre of the wheel in order to obtain a secure hold. The advice tendered by the makers of wheels for commercial purposes is applicable to their employment for dental work, and the following are some of the points to which special attention is

directed. Wheels should never be mounted without flanges, these should be at least one-third the diameter of the wheel, and should always be concaved or relieved, never straight or convex (Fig. 109). The inner flange should always be fixed on the spindle, never loose. Flanges on both sides of the wheel should be of the same diameter and they should be accurately parallel. Rubber, or pulp washers slightly larger than the flanges should be used between the wheel and the flanges in order to distribute the pressure evenly. Flanges should only be tightened enough to hold wheels firmly. A liberal supply of chucks, at least double the number which usually accompanies the lathe outfit should be provided, and they should have long and short necks to take the different sizes and thicknesses of wheels, as much time is thereby saved in changing from one size of wheel to another. For instance, a large wheel may be used on the left hand chuck for rough grinding, while a smaller wheel is ready for use on the right hand chuck. In this way not only is time saved, but generally speaking a wheel need not be removed from the chuck on which it is mounted before it is worn down, and until it is of no further use. The lathe should also be provided with a drill chuck which will take any drill or mandrel near the size of an engine bur. Thus the various stones, discs, and points for the dental engine, are also available for

FIG. 109. A, Showing correct form of chuck. B, Showing usual form of chuck.

use with the lathe. Before mounting a wheel, especially a new and large-sized one, it should always be tapped lightly to make sure from its tone or ring that it is sound. A wheel should never be forced on to a spindle, otherwise there is danger of bursting it. See that it goes on easy, and that the whole rotating system is perfectly balanced.

Fig. 110A shows a Columbia lathe which can be readily fitted with a flexible cable arm (see Fig. 110B), and this arrangement will be found particularly useful in connection with the shaping up of crowns and bridges from tube teeth and porcelain rods, and for many other purposes. An attachment such as that shown costs very little, and can be obtained separately, thereby permitting of the use of any old foot or other engine cable arm, and the attachment can be slipped on or off the spindle in the same manner as a wheel chuck. The dental engine will be found useful in place of the flexible arm attachment for the lathe and for final shaping up of teeth, crowns, or bridges. At the chairside it is indispensable.

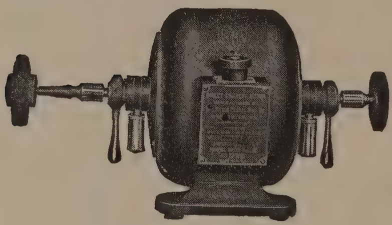


FIG. 110A.

Before proceeding to give a detailed description of the methods employed in shaping up tube teeth or porcelain rods for the purpose of forming crowns, bridges, porcelain plates, or similar prosthetic appliances, and with the object of maintaining, as far as possible the continuity of the subject of abrasive wheels and materials, a list of the most suitable at present available will be given. It has been already

pointed out that it is unfortunate that the system adopted for the wheels for general trade purposes has not been followed in the case of dental wheels, as the complaints one so often hears of wheels being

FIG. 110B. Flexible Arm Attachment.

too soft or too hard would have less point if we knew that we could obtain any grit desired in a variety of grades; but even although this advantage is not obtainable, excellent work may be accomplished by the use of the wheels given in the following table, in which carborundum is chosen as probably the best known.

Carborundum Vitrified Wheels

Diameter	*Thickness*	*Grit*	*Edge*
3 in.	$\frac{3}{8}$ in.	B. Extra Coarse	Square
3		B. Extra Coarse	Knife
3		C. Coarse	Knife
3	$\frac{3}{8}$	C. Coarse	Square
3	$\frac{3}{8}$	D. Medium	Square
$2\frac{1}{2}$	$\frac{3}{8}$	B. Extra Coarse	Square
$2\frac{1}{2}$	$\frac{3}{8}$	C. Coarse	Square
2	$\frac{3}{16}$	C. Coarse	Square
2	$\frac{3}{16}$	D. Medium	Square
$1\frac{1}{2}$	$\frac{3}{16}$	C. Coarse	Square
$1\frac{1}{2}$	$\frac{3}{16}$	D. Medium	Square
1	$\frac{1}{8}$ and $\frac{1}{16}$ in.	C. Coarse	Square
1	$\frac{1}{8}$ and $\frac{1}{16}$ in.	D. Medium	Square
$\frac{1}{2}$	$\frac{1}{16}$ in.	C. Coarse	Square
$\frac{1}{2}$	$\frac{1}{16}$	D. Medium	Square

Wheels as used for ordinary engineering purposes

Diameter	*Thickness*	*Grit*	*Grade*
4 in.	$\frac{3}{8}$ in.	80	K to N
4	$\frac{3}{8}$	100	K to N
3	$\frac{3}{8}$	80	K to N
3	$\frac{3}{8}$	100	K to N

In addition to these, a large selection is necessary of the smaller sizes of carborundum wheels, points, and discs suitable for use in the engine handpiece, or on the lathe.

Doubtless the foregoing list appears a formidable one, and in excess of probable requirements, but as these vary greatly, as already pointed out, it is considered advisable to guide the reader in making a suitable selection, even although it appears unduly large.

With regard to the use of the various carborundum wheels, the largest and coarsest should be employed for cutting a large tooth down to a smaller size, or for cutting off sections from porcelain rods. A wheel 4 or even 3 inches in diameter, $\frac{3}{8}$ths of an inch thick, grit 80 or 100, grade I to M, the latter being softer than the former, will cut through the largest

tooth or porcelain rod with a rapidity which will greatly astonish those whose ideas of fast cutting have been confined to the use of wheels perhaps not greater than $2\frac{1}{2}$ inches in diameter, and of grit, say 120 to 150, and grade unsuitable for the purpose. (Fig. 111). When one has had some experience with these large wheels, it is surprising to find with what accuracy and speed they accomplish the work, how quickly skill may be acquired in their use, and how much shaping up may be done without resort to the use of smaller sizes. The rate at which even these large and coarse wheels cut, is much more under control than one would think possible. Certain drawbacks to their use which might reasonably be looked for will be found absent, or will only make themselves felt as the result of carelessness, such as undue pressure on the porcelain, along with an insufficient supply of water. These may result in excessive heating, and so produce a tendency to chipping or cracking of the porcelain, but these risks can be avoided, and even greater cutting power obtained by the use of elastic base wheels of similar grit. The use of the smaller sizes and finer grits may be left to the judgment of the operator, but he should be careful to postpone the use of these as long as possible, and

FIG. 111. A, Shows double tube rod No. 30. B, Shows double tube rod No. 30 with V shaped cuts. Times for making cuts 35 and 45 secs., using 4 inch Carborundum wheel grade M, grit 80. Spindle speed 1200.

accustom himself to do as much as he can with the larger sizes. Before leaving the subject of carborundum wheels, a warning is necessary with regard to their use, which also applies to corundum wheels used for grinding porcelain: That is, always grind

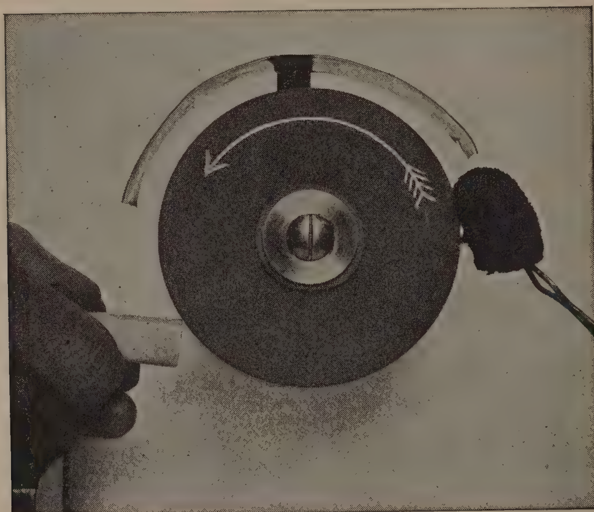


FIG. 112. Shows right way of presenting rod to wheel. Also shows simple device to prevent splashing.

towards the edge (Figs. 112 and 113), as otherwise there is a danger of splintering the tooth. This precaution must be carefully observed when using large wheels of coarse grit, but applies also to the finer and smaller wheels, although with these the danger is diminished, and with suitable elastic base it is altogether absent.

Smoothing and Polishing Porcelain Teeth

This is a subject which has been much neglected, and those who have written about it have handled it in a manner which seems to suggest that they lack

confidence both in the methods they advocate, and the results obtained. Doubtless better methods would have been evolved under more pressing circumstances, but as our necessities have been fairly well met as previously mentioned by an extensive selection of tooth forms, the subject failed to receive that attention which it deserves. Moreover, en-

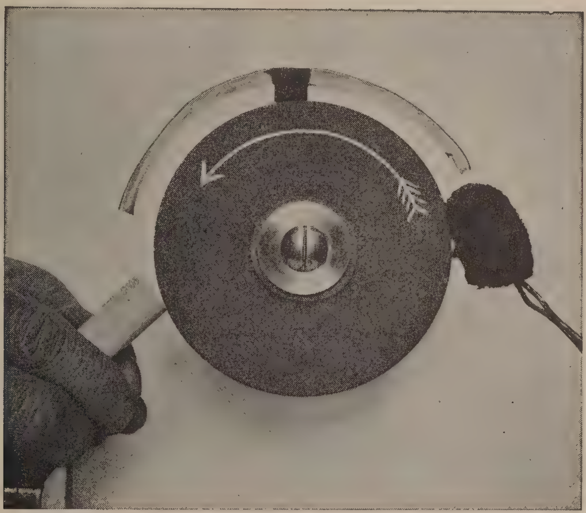


FIG. 113. Shows wrong way of presenting rod to wheel.

couragement has never been given to interference with the labial or buccal surfaces of porcelain teeth.

The method usually suggested is to smooth the ground surface by means of a wheel of the finest grit of corundum or carborundum, and afterwards by means of an Arkansas stone mounted on the engine handpiece, followed by a small wooden wheel or moose-hide buff, armed with oxide of tin or pumice powder with water. While a polished surface can be obtained in this way, the process is slow, and the

results are so unsatisfactory that the methods herein advocated with regard to the shaping of teeth would have been so handicapped by it as to preclude their development. Fortunately, there are methods both speedy and thorough whereby this may be accomplished. The first of these methods consists in smoothing the whole of the ground surface by means of a special stone, "Nitor" stone, a soft but tough natural stone of pale grey and biscuit colour. These stones may be had for the lathe in various sizes, and also in a variety of shapes for use in the dental engine, when they are known as Nitor stone. Their peculiar properties consist of smoothing and at the same time imparting a dull polished surface, and this work may be rapidly carried out after the use of even the coarsest carborundum wheel, though it is best to go over with a fine carborundum wheel first. The polishing wheel should be kept thoroughly wet, and the whole of the ground surfaces gone over lightly and rapidly with a zigzag motion. For those surfaces which it may be found impossible to smooth by means of a large wheel, the smaller sizes should be used in the engine. About two or three minutes should suffice to smooth the largest size of tooth.

A second way is to use an elastic base wheel, grit FFF, for smoothing. Such a wheel gives a dull egg-shell polish, which is sufficient in many cases, and permits of a high polish being rapidly developed by buffing. No form of vitrified or silicate bond will permit of this being done, as these leave too rough a surface — indeed their employment means an endeavour to smooth and polish porcelain with an unpolished porcelain surface, because, as has been

already shown, the bond (porcelain) of vitrified and silicate wheels is in itself an abrasive — in fact the vitrified bond is a porcelain bond, while the silicate bond is a glass one, — and when the finest grits (flours) of abrasive materials are used as the grinding or polishing medium, they are of finer grit than the porcelain bond. Thus another argument is advanced in favour of the elastic bond.

Another means of obtaining a smooth surface for polishing is by means of Ash's tan stone, a tough natural stone of pale cinnamon colour. These stones may be had for the lathe as well as in a variety of sizes and shapes for use in the dental engine.

Yet another method whereby similar results can be obtained is by means of a brass or copper wheel about $1\frac{1}{2}$ or 2 inches in diameter, or even larger, for accessible surfaces, and $\frac{1}{4}$ or $\frac{3}{8}$ of an inch thick, along with FFF carborundum or crystolon powder, and sugar solution applied in the manner described in connection with the use of metal discs for cutting sections of porcelain, or grooves in it; and the surface of the porcelain should be smoothed in the same way as described in connection with the Nitor polishing stone, followed in like manner by the use of a buff on the lathe along with pumice powder and water. For the less accessible surfaces, small metal wheels, discs, or points, or wood points, should be used. These latter should be similar in shape and size to the carborundum pencil points commonly used, and they should be mounted in the porte polisher in the same way, and used with a rubbing motion.

Polishing. After the surface has been smoothed by any of the previous methods, a polish equal to

new may be given by means of a felt wheel or buff of about 2 inches diameter, kept thoroughly wet by means of a sponge charged with fine pumice powder and water. The highest gloss is to be obtained by finishing with the buff nearly dry, but care must be observed not to heat the porcelain, otherwise it may crack.

To polish surfaces which are inaccessible to the ordinary buff, a knife-edged one along with pumice and water or a very stiff brush may be used. Under certain conditions thin string loaded with pumice and water is also useful.

General Remarks on Grinding Materials and Methods

On referring to the standard works on prosthetic dentistry and to the extensive literature of our specialty, it will be seen that the subject of grinding, shaping, and polishing porcelain teeth has not received the attention which its importance warrants. Some of the reasons for this neglect have been already dealt with, and need not therefore be fully restated. The principal ones were the inferiority of the grinding materials and appliances in use before the introduction of the artificial abrasives and the power-driven lathe. In addition to these, satisfactory methods of smoothing and afterwards polishing were then unknown, especially in the case of moulded teeth — then far more extensively used than poured teeth (see page 54) — as the moulded teeth presented a porous surface after removal of the enamel glaze. This latter drawback is still apparent, although recent improvements in the composition of most moulded teeth has greatly lessened it. As the disadvantages referred to may be said to have

disappeared, there is no longer any reason why men should hesitate to grind any or all of the surfaces of porcelain teeth, as an efficient and rapid method of polishing is now known. The absence of these seemingly unimportant facilities for smoothing and polishing, had more far reaching effects than were at first apparent and were without doubt the main factors which led to the rapid increase in the number of patterns of porcelain teeth and crowns which continues to the present time. Some of these disadvantages have been already referred to, such, for instance, as the impossibility of even the best-stocked dental depot being in a position to stock a selection of nearly all of them, and the amount of time expended in an endeavour to find what is sought for. In addition to this is the disadvantage which has arisen from a too great dependence on the multiplicity of tooth forms for the purpose of obtaining artistic results. In consequence of this dependence, we have failed to realise that the problem cannot be solved in this way, and so an alternative solution must be found. This can only be done by having regard to the possibility of shaping and polishing any or all of the surfaces when necessary, consequently we must not be content to rely on the manufacturers in the hope that they will be able to provide us with teeth and crowns designed to match the natural ones in all cases. Unfortunately, the ordinary forms of teeth and crowns do not lend themselves, in most cases, to much alteration in shape, for the reason that there is seldom a sufficient surplus of porcelain to permit of this. At the same time the makers of artificial teeth have good reason to call in question our claims to practical application of the artistic

aspirations we lay claim to, and in proof of their scepticism need only point to the necessity they have been under of withdrawing many of their natural pattern and countersunk tooth forms. Tube teeth and porcelain rods however, do provide the necessary raw material, but it is not to be assumed that only a few forms of these in a variety of shades should be at our disposal, or that the huge selection of teeth and crowns at present provided are altogether needless. Neither must the idea be entertained that it is held advisable to carve up the majority of teeth from tube forms or porcelain rods. This would be going to the opposite extreme, and it is fully realised that the conservation of time and nervous energy, does not permit of this except in a limited number of cases. Cases, however, are by no means uncommon where extensive modification of tooth or crown forms is called for; and it is well to be able to produce what we require from the rough block, while the experience which this yields is of incalculable value in training hand and eye in a manner, and with a thoroughness impossible in any other way. That some such form of special training is called for is attested by the experience of men well qualified to judge. Indeed, no thinking man will deny that prosthetic dental art calls for more than the mere selection and arrangement of teeth. Almost without exception, the artist has begun his career by becoming a craftsman, and has learned from the clay, the rough marble block, or the canvas, and so should the student of prosthetic dental art. Fortunately, the necessity for this is apparenttly being realised, as is proved by the endeavours which are being made to train students in the art of carving up teeth from

ivory and other similar materials to imitate the natural teeth. All such teaching is highly advisable, and every encouragement should be given to further expansion in this direction, and to the revival of the old-time form of manual training afforded by the carving of plates and teeth from the rough ivory block. It is doubtful, however, if such training goes far enough, or if the methods taught are likely to be useful in practice, valuable though they admittedly are in training the student in manual dexterity and appreciation of form. As a most important adjunct then, to present methods, the writer would strongly urge that students be taught to grind and shape up teeth from porcelain rods; and he believes that no training could be afforded better calculated to familiarise the student with the variations in tooth forms and so furnish him with a practical knowledge of the surface anatomy of the teeth, which he would find it difficult to acquire in the same thorough way by any other mode of procedure. By the time he had learned to shape up a few upper and lower sets of teeth in this way, much experience would be gained, and if the training were extended to the fitting of such teeth to a rigid base, such as a metal plate, or to capped roots, this in addition would serve to revive the almost lost art of fitting teeth, which the enormous selection has done so much to kill. That tube teeth supply the training and yield the results claimed has been abundantly proved by those who practise this line of work. It is to be borne in mind also that porcelain is a more suitable material than bone, ivory, or any of the metals for the purpose of acquiring the art of tooth-shaping, for the reason that porcelain is one of the

materials which the student in his after career will be constantly called upon to shape up by grinding, whereas the other materials spoken of, which are sometimes used in this connection for teaching purposes, lend themselves more readily to carving with hand tools; and important though such teaching undoubtedly is, it does not supply the necessary training in grinding which porcelain does. Another important point in connection with porcelain rods for teaching purposes is their cheapness. The most common test of a student's skill in plate work is the shaping and fitting of a set of single gum teeth to a metal plate. Surely a much better test would be afforded by the shaping up of a set of tube teeth, either from larger forms, or from tube rods, and afterward fitting them to a metal plate. The experience thus gained would be of much greater value afterwards, as a large proportion of the cases the young dentist will have to deal with in his professional career will be better met by the use of tube teeth than by those of any other form; and he will find that it does not take long before his manual dexterity so far approximates to the level of his artistic aspirations, that he will seek for fresh models, which are constantly before him in his every-day life.

CHAPTER X

GRINDING, SHAPING AND FITTING, SINGLE AND DOUBLE TUBE CROWNS FROM TUBE TEETH AND PORCELAIN RODS

WITH regard to shaping up of teeth it has already been pointed out in a previous chapter that a sound knowledge of the various types and forms is a great help.[1] As an aid to the acquisition of this knowledge, it is well to gather together as many specimens of typical natural teeth as possible, and when occasion arises one of these should be selected which most nearly conforms to the type required, and this should be used as a pattern. It is surprising what a help a pattern tooth affords, as one is apt to imagine he knows the exact surface anatomy of each tooth, but when it comes to cutting up a duplicate from a large size of porcelain tooth or rod, one's ideas are apt to get confused. Gradually, as one gains experience, it will be found unnecessary to keep the pattern fixed always before one; but until such experience has been acquired it is a distinct advantage to have such a model from which to work (Figs. 114 and 115). Without in any way seeking to minimise the importance of a study of the surface anatomy of the teeth,

[1] The writer would advise the reader to study the chapter "The Anatomy of the Human Teeth," by Dr. C. R. Turner, in Dr. C. N. Johnston's "Operative Dentistry." So far as the writer is aware, the illustrations and text are superior to anything else on this subject.

it seems right to point out that the process of tooth shaping from porcelain rods is mainly a copying one, and that three-fourths or more of the work can

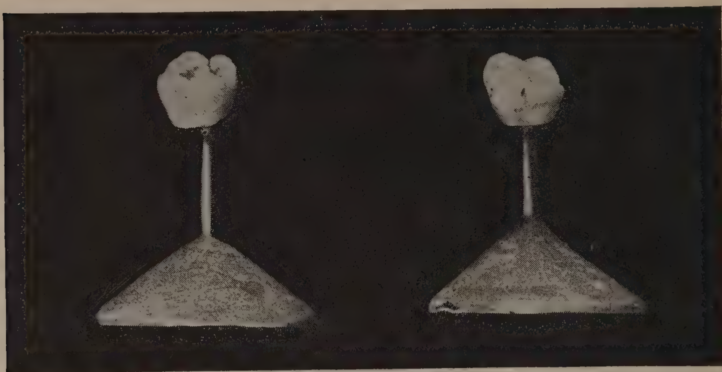


FIG. 114. Shows patterns for copying.

be done by comparatively unskilled hands, such as by dental mechanics or lady secretaries.

In order to illustrate the method of fitting and shaping a tooth or section of a porcelain rod for forming a crown, we shall take a case involving the

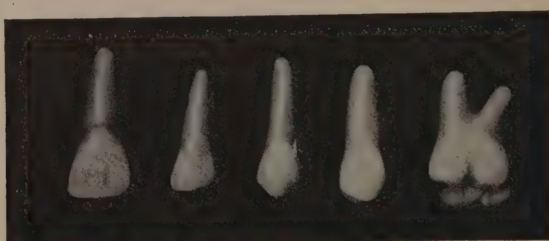


FIG. 115. Shows S. S. White's Technic Teeth.

mounting of a front tooth crown on a capped root. Having obtained a good model and bite, the next thing is to select a suitable tooth, care being observed to note that its base is sufficiently large to cover the surface of the cap, and to allow a little surplus

material all round. It must in addition be of sufficient length to allow for letting down, and so may call for a good deal of grinding. In order to so reduce it rapidly, the largest size of coarse square-edged wheel should be employed, and the tooth ground all round its cervical edge, until its base is reduced to a cone, which should then be truncated until a square end to the tooth is again formed, proceeding, if necessary, as before; or it may be nearly cut through with a knife-edged or mitre-edged wheel, or by means of a thin three or four inch metal disc with abrasive powder. When the tooth is being formed from a porcelain rod, separation may be effected by nearly cutting it through in the manner described, when it may be broken off with the fingers by means of a tap on the bench, or with a small device designed for this special purpose consisting of an instrument with two chisel blades placed vertically, guillotine fashion, the upper one of which is movable. (Fig. 116). The tooth being inserted between the blades, the portions should be severed by a sharp tap.

The fitting of the tooth to the cap requires a considerable amount of practice to do quickly and well, and it is an advantage to remove the latter from the model, so that all sides can be seen with ease. The tooth should be placed on the post in the position it is to occupy, and the space noted at its widest point where it does not touch the cap. (Fig. 117). In order that this point may touch the cap, grind off the porcelain from the part that does touch and here the ordinary size of wheel may require to be used from 2½ to 3 inches down to the smallest size, and of such grit as best meets the circumstances. The choice must be left to the judgment of the operator,

but a point to be noted is that for the purpose of rapid working the wheel employed should be the largest that can be suitably used. When one has had much experience in fitting tube teeth, the unaided eye alone serves to note with accuracy the points of contact, and the amount which should be

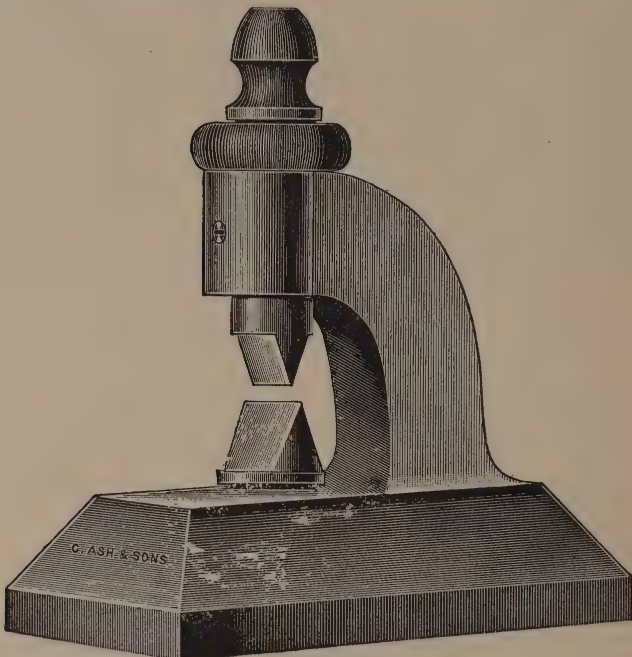


Fig. 116. Cutting Tool for shortening tube teeth — full size.

ground off; but until then the rough-fitting is rendered much easier by the use of non-drying vermilion paint, and for fine fitting this help is nearly always necessary. Some take exception to the use of paint or colouring matter as an aid to tooth fitting, maintaining that these are never necessary. However, in tube work such aid as paint affords cannot with advantage be dispensed with for rapid and accurate

fitting, and it is to be observed that with tube teeth once the post or pin is soldered, it prevents the ground base of the tooth from being marked by rubbing it on the metal base with the object of indicating the part which requires to be ground, as with an ordinary flat tooth.

The method of applying the paint is as follows: — With a small brush spread a thin coating over the surface of the cap, place the tooth on the post, and let it down gently until it touches. Then remove the tooth, and a slight vermilion mark will indicate the

FIG. 117. Shows stages in the shaping and fitting of a front tooth crown from a large special non-platinum front tube tooth.

point of contact. Grind this down, and again try on, when it will be found to touch, possibly at the same, or at one or two more points. Continue the grinding and trying on until a fairly accurate fit is obtained. Care should be taken to have the base hollowed out round the tube a little more than is actually necessary, but not extending to the margins. In the case of the platinum tube tooth the steel countersink should be sufficient for this, and if dipped in turpentine it will cut more easily. With reference to the rough fitting, it is very necessary to note the direction of the tooth each time it is let down on the cap after grinding. By failing to do so, it is not uncommon to have a perfect fit of the base of the tooth to the cap, while yet in obtaining this the

direction may have unconsciously been altered, especially when it is being fitted to a steeply sloping surface. This applies particularly to the early stages of fitting. Such a mistake can, of course, be easily remedied if there is ample bulk of porcelain.

Fine fitting. The fine fitting is to be continued in the same manner as the rough fitting with this difference, that smaller sizes of wheels are generally used, but as already mentioned the size of wheel most suitable for each case must be determined by the judgment of the operator; and it will frequently be found, especially in the case of teeth with a small base, that small wheels require to be used from the first, say those of an inch in diameter and downwards. Generally speaking, however, the larger and more regular the surface of the cap, the larger the wheel which may be employed. The accurate fitting of the tooth to the cap is a matter of much importance with regard to strength and security of attachment of crown and post. A crown may have its base and tube hollowed out to excess, while the margins fit well, but obviously such a fit is a false one, obtained by excessive sacrifice of porcelain, and consequently of strength. But there is an additional evil, and that is the weakening of the attachment of the crown to the post owing to the excess of cementing material necessary. Moreover a crown accurately fitted to the cap is far less liable to the danger of rotation; indeed this is impossible unless the cementing medium used is exceedingly poor.

To judge the accuracy of fit try to rotate the crown on the cap, at the same time pressing upon it. If lateral movement is observed, then the crown is not fitting over its whole surface. Lastly, the marginal

fit should be such that no space is visible between the porcelain and the gold cap.

Having fitted the base of the tooth to the cap, the next step is to grind off sufficient of the approximal surface to allow the tooth to get into the space; and before doing this it is a good plan to trim a small portion off each of the adjoining teeth on the model, say about the thickness of a visiting card, as this will ensure a margin of porcelain being left to be cut off the tooth when it is adjusted in the mouth.

The next step is the shaping up of the tooth, and this consists in first reducing its circumference at the base until it is of a size to conform with the cap. For this a square-edged wheel, 2 to 3 inches in diameter, $\frac{3}{8}$ of an inch thick, and grit 120 or even 150, will be found most useful, as there will be less liability to chip the edges with this than by using one of a coarser grit, although it is surprising with what safety one may grind even with coarse wheels, provided the proper method is employed, viz., grinding towards the edge, as in Fig. 112.

Having thus fitted the tooth into the space, its face should next be ground so as to bring it into alignment with the adjacent teeth, care being taken to leave it a trifle longer than necessary. The art of grinding and shaping these surfaces so that they may be left smooth and free from facets is one which is much more easy to demonstrate than describe. The requisite smoothness is obtained by employing a swinging movement up and down, at the same time imparting to the tooth a slightly rotary motion. Instead of using the expression "swinging movement," it would perhaps better convey the idea to call it a rubbing movement. By this means a fine

smooth rounded surface is obtained, and one which lends itself readily to subsequent smoothing and polishing.

The lingual surface of the tooth is next to be ground to conform in shape with the adjacent teeth, and to the bite. The necessary hollowing out is best done by means of a wheel about $\frac{3}{8}$ of an inch in diameter, $\frac{3}{16}$ths of an inch thick, and of coarse or medium grit, which will give approximately the correct concavity, and so produce a surface free from irregularity. To one unfamiliar with the strength of tube teeth, the amount which may require to be ground off the lingual surface may appear to leave the tooth dangerously weak, but little fear need be felt on this score, as will be seen on referring to Chapter IV, page 49.

The crown may now be considered finished as far as work on the model is concerned. The subsequent steps in the process of shaping should be done at the chair side, and a description of this will now be given. After the adjustment of the cap to the root, the tooth should be tried on, when it will be found to touch hard on the adjoining teeth. The points of contact should be carefully noted, and with a small flat-edged wheel in the engine these should be carefully ground off, care being taken not to remove too much at a time.

The trying on of the tooth should be continued until perfect approximal contact is obtained. The fit, however, should be fairly tight, to allow for smoothing and polishing, as in doing so these surfaces are slightly reduced.

Next, the incisive edge should be cut to the proper length using for this purpose a fine square-edged

wheel, and the mesial and distal corners rounded according to the requirements of the case. At the same time the mesio- and disto-lingual surfaces should be rounded off and reduced to a natural shape. The cingulum too may be shaped up to conform with the character of the adjoining teeth. With regard to the amount of porcelain on the lingual surface, it is to be remembered that this largely depends upon the position and inclination of the post, and that this, as previously pointed out, can be controlled to a large extent; the endeavour should, therefore, be made to have the post directed as far forward or outward as is consistent with a due regard to avoiding the danger of its showing on the labial surface after the crown has been finally shaped up.

The foregoing general description is applicable also to the various classes of teeth and crowns already spoken of, and hereafter to be described.

Naturally it is impossible to give much guidance in this matter, as it is one which does not readily lend itself to a written description, even when supplemented by illustrations. In this it shares the difficulties that attend attempts to deal with the illusive character of the technique of art; and so an endeavour will presently be made to describe the use of grinding wheels for the purpose of producing most natural effects. Generally speaking, the engine will be found more useful than the lathe, not only because of its greater flexibility, but also on account of its closer proximity to the chair and the facility thus afforded of obtaining the natural teeth as a guide in shaping up. At the same time these advantages are not always necessary, though very desirable in the case of the incisors. Moreover, a model

alone will suffice for obtaining as good results as in the case of any other form of crown, and so the final fitting, shaping, and polishing may be completed without resorting to the refinements spoken of, desirable though these are in most cases.

The tooth should be held in the left hand along with a small piece of sponge which may be attached by means of shellac to a tailor's thimble as shown in Fig. 118 or the grinding may be done dry; the stones which will be found most generally useful are those about $\frac{1}{2}$ inch by $\frac{1}{8}$ or $\frac{3}{16}$ inch thick, square, and round-edged and grits C and D. Finer grits are seldom desirable, and a soft rather than a hard grade is best, as not only may the work be done faster, but more character thrown into it. These should be run at a fairly high speed, and used with a moderately fast drawing motion, grinding always towards one — making as it were about 30 to 60 draws in the minute, in short, using the stone something like a paint brush (Fig. 119) but, of course, very much faster, and always drawing from above downwards. Another method of using the wheel and one which produces an excellent surface is to secure a rapid circular motion in a direction at right angles to the direction in which it is revolving. The motion may, indeed, be described as a rubbing one. While the stone is being manipulated as described, the position of the tooth should be varied as re-

FIG. 118. Tailor's thimble with sponge attached.

quired, and here it will be observed that greater freedom is possible than when the lathe alone is used for giving the final touches. At the same time, results almost as satisfactory may be obtained in the following manner by the use of the lathe alone, in all but exceptional cases. As only one motion of the grinding wheel is possible, the tooth must have its various surfaces which require shaping presented to it, and this should be done by moving the tooth up and down, and at the same time backwards and forwards across the face of the wheel; and the tooth should not be removed from it except for the purpose of noting the progress made.

FIG. 119. Showing method of grinding.

Grinding under Water. When dealing with the subject of the superiority of the tube tooth over other existing forms, it was pointed out that in the event of fracture of a ready-made crown, and also some other varieties the tube of the tube tooth could be readily shaped to conform with the basal

anchorage of the broken one by means of Butler's carborundum points and small wheels. The trouble associated with the use of these results from the difficulty of keeping them from becoming overheated, as the use of a small piece of wet sponge does little to prevent this, and repeated dipping of the point in water is both slow and troublesome, and results in the temptation to go on grinding until there is a danger of spoiling the point. In order to avoid this, and at the same time to do the work more efficiently and very much more quickly, the writer has been in the habit of employing a small rubber cup, in which the tooth is placed (Fig. 120) and held securely by the fingers of the left hand. These small rubber cups are known as rubber thimbles, and are used by bankers when counting paper money. The cup is partially filled with water, the amount of which can be regulated by the pressure of the fingers which grasp the tooth, so that it may be kept covered during the grinding process, and uncovered by slightly relaxing the grip when it is desired to ascertain how the grinding progresses. In this manner the point may be safely run at high speed without danger of overheating, and with a fair amount of pressure the tube tooth may be given such shape as is desired. When a double rotary motion is imparted to the point, it cuts much faster. The method suggested will also

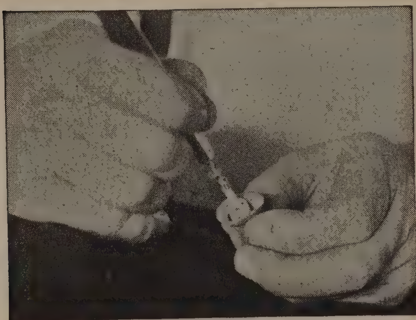


FIG. 120. Grinding under water.

be found useful where small stones are employed, and is particularly valuable where diamond drills, points, or discs are used, but without the rotary motion. It is to be observed that the tube in a tube tooth or porcelain rod is a very great help when a recess has to be formed; while an alternative method of procedue in connection with the method already described, of grinding under water, is to partially embed the tooth or facing to be ground in a mass of dental lac or modelling compound placed in and stuck to the bottom of a small metal cup which can be partially filled with water.

The Shaping up of Teeth from Porcelain Tube Rods

Having described the shaping up of a front tooth crown from one of the larger forms of tube teeth, it is now proposed to explain the method whereby a similar tooth may be formed from a porcelain rod. A porcelain rod should be selected of suitable shade and large enough to cover the cap, and for this purpose the second largest size of single tube rod will be found suitable for all but exceptional cases. Having removed the cap and post from the model proceed to fit the end of the rod to it in the same manner as previously described, and having rough-fitted it, make two slanting cuts in the rod, one on each side (Fig. 121) which are to correspond with the labial and lingual surfaces of the crown. These should be made with the edge of the large size (4 inch) wheel, and while the cut which is towards the lingual surface should be made deep enough to reach the tube, that on the labial surface should only reach about half way. The distance of the cuts from the base and the angle at which they are made will depend upon

the length of the tooth required. Fig. 121 shows these cuts and the time required to make them. The tendency at first will be to cut off too much rather than too little, but the surplus can be so quickly ground down that it is well to err on the safe side. Next, separate the rough block from the rod, which may be done by means of a knife-edged wheel, or it may be broken off with the fingers or by a tap on the bench as already described.

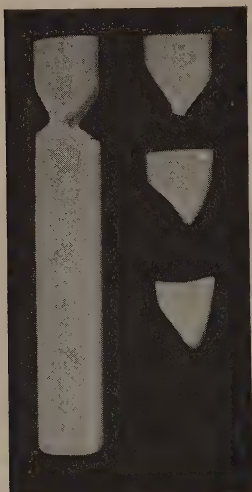


FIG. 121. A, Tube rod, No. 24 with V-shaped cuts. Time taken to make cuts, 30 sec. B, C, D, Stages in shaping-up tooth. Total time, 3½ min.

An alternative method is to cut off the desired section of porcelain rod before proceeding to fit it to the cap. Rough shape it up and then proceed to fit it to the cap in the ordinary way.

Another method is to shape up the tooth as far as is practicable before severing the connection between the partially finished crown and the rod, which latter can be used as a handle for holding the tooth during the process of shaping up, and in the case of small teeth will be found of real practical service. It has one drawback however, and that is by delaying the severance of the tooth from the rod, one's ideas of the true anatomical proportions of the former are apt to get somewhat distorted, and the relation of the tooth to the rod is not easily judged until one has had considerable experience. Therefore, at first it is better to cut off the necessary amount of

porcelain and then shape up the tooth as follows: — By means of the large flat-edged wheel of 4 inches in diameter, $\frac{3}{8}$ths of an inch thick, and grit 80 or 100, shape up the labial surface in the way already spoken of in dealing with the shaping up of a crown from one of the largest forms of tube teeth, taking care to grind from the cervical margin towards the cutting edge. The amount which can safely be ground off in the process of rough shaping can be

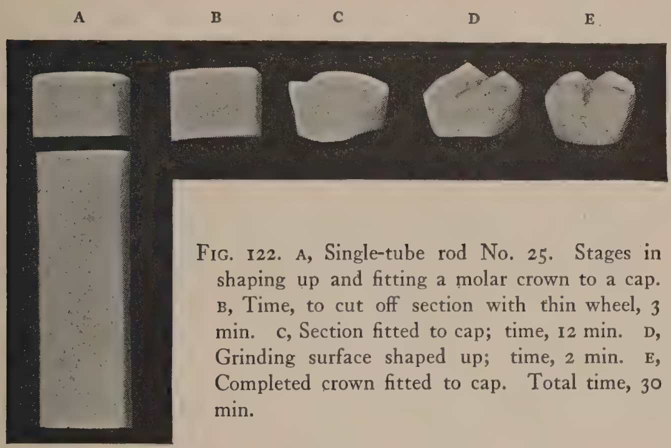


FIG. 122. A, Single-tube rod No. 25. Stages in shaping up and fitting a molar crown to a cap. B, Time, to cut off section with thin wheel, 3 min. C, Section fitted to cap; time, 12 min. D, Grinding surface shaped up; time, 2 min. E, Completed crown fitted to cap. Total time, 30 min.

readily judged by the position of the tube, which, it will be remembered, should be as near the labial surface of the tooth at its incisive edge as can safely be done without the post showing through, thereby obtaining the maximum strength of porcelain.

The subsequent steps with regard to fine fitting, shaping and polishing have already been described. Fig. 122 shows a method of forming a molar tooth from rod No. 25. Attention will now be directed to shaping up other forms of teeth.

It has been seen that owing to a deficiency with regard to the supply of incisor and canine crowns

large enough in the base for forming crowns or for use in plate work where they have to be set into the gum, recourse has meanwhile to be had to the special forms of tube teeth made for this purpose. This is no drawback, however, once it is realised how easily and quickly a tooth or crown may be shaped up from a tooth approximating in size to the one required even when of a different type. Thus for the purpose of forming a lateral incisor crown, a bicuspid of the right colour should be selected and first ground to fit the cap and afterwards shaped up as in Fig.

A B

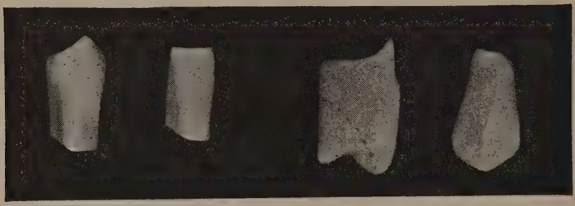


FIG. 123. A, Lateral incisor formed from tube bicuspid. Time, 1 min. B, Canine formed from the extra large non-platinum tube bicuspid. Time, 1 min.

123 A; or the tooth may first be roughly shaped up as a lateral incisor, and afterwards fitted to the cap.

The Canines. Any of the upper or lower canines can be quickly shaped up from one of the special forms of bicuspids, see Fig. 123B, where it will be seen that very little grinding is required other than removal of the lingual cusp.

The Bicuspids and Molars. Little requires to be said regarding these as an ample selection will be found suitable for all ordinary cases and without the necessity for much grinding to fit them for the purpose. For crown work, and in certain cases in plate and bridge work, the special forms will be required,

but for most cases of plate and vulcanite the ordinary forms of narrow-based teeth will serve all purposes. In the case of bicuspid and molar crowns, the matter of approximal contact is of the greatest importance, and must always be kept well in view. Indeed, at the conclusion of the final shaping up, the crown should require some slight pressure to force it to place before the final polishing is done, as the polishing slightly reduces it, but very slightly if done with care.

In shaping up the grinding surfaces the depths of the sulci will depend upon the bite, and they should be cut boldly by means of a fairly large wheel, and the angles subsequently rounded off with smaller wheels in the process of final shaping, smoothing and polishing. The lower teeth call for no special mention, as what has been said regarding the upper teeth applies to them also. There is this difference, however, that some of the ordinary forms of tube bicuspids which are too small in the base for the purpose of covering capped upper bicuspid roots, are well suited to covering the lowers.

The Fitting and Shaping of Crowns from Double-tubed Rods

In Chapter II, certain classes of cases have been mentioned with regard to which the employment of double-tubed rods will be found of advantage, both in crown, bridge, and plate work, and it is proposed to describe how this may best be done.

While it would appear that the difficulty of shaping two or more teeth from one block is greater than where only one tooth has to be formed, it is easily done. At the same time it must be borne in mind

that the crowns cannot be treated as independent factors, but their relation to each other must receive consideration from the first. A model and bite having been obtained, and assuming the case to be one in which a left central and lateral crown are required, (Fig. 124) the first thing to be done is to select a pair of teeth, either natural or artificial,

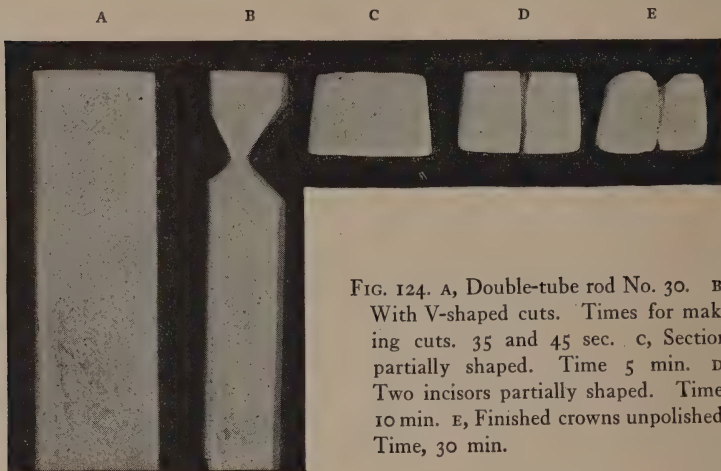


FIG. 124. A, Double-tube rod No. 30. B, With V-shaped cuts. Times for making cuts. 35 and 45 sec. C, Section partially shaped. Time 5 min. D, Two incisors partially shaped. Time, 10 min. E, Finished crowns unpolished. Time, 30 min.

which will match in size and form those required, and adjust them in their proper relation, as without such a model or pattern to work from, one's ideas of proportion and form are apt to be somewhat confused, at any rate until considerable experience has been gained. The double tubed rod No. 30, in which the tubes are 5·5 mm. apart,[1] will be found to suit the majority of such cases. But if the central and lateral required are extra broad, or their roots are some distance apart, then a larger size of double

[1] In all cases in which reference is made to the distance apart of tubes in tube rods it is to be understood that the measurements are from the nearest points.

tube rod should be used, one in which the tubes are 6·5 or even 8 mm. apart. It is not to be expected, however, that both tubes can always be situated centrally in their relation to the individual caps, nor is this necessary, and so that portion of one of the posts which projects above the cap has sometimes to be cut off to begin with, and replaced after the tooth block has been rough-fitted. Anyhow, it is best to count on having to do so, though the percentage of cases in which the position of the posts corresponds with that of the tubes is surprisingly large, not only in the case of a central and lateral, but, as before mentioned, the canal at the gum level of most adjoining incisor and canine roots, and also of many upper and lower bicuspids will be found to be 5·5 mm. Slight reaming out of the tubes is sometimes necessary, in order to avoid the necessity of resoldering one of the posts, and this may be done without materially weakening the crowns, but it is always best to resolder unless a very slight amount of reaming only is required, and the manner in which this may be most efficiently and rapidly done is described on page 121. The next step is to roughly fit the end of the rod to the caps with the narrow side of the rod towards the central incisor, from which a small amount has been removed from the mesial surface of the plaster tooth to allow of slight fulness of the porcelain at this point in view of final shaping up later on. Having roughly fitted the block to the caps, proceed next to make a double cut in the porcelain rod as described in the case of the single tube rod, observing to have it deeper on the lingual surface (Fig. 124 B) and to leave it sufficiently long for shaping up. Next separate the rough block from

the rod, and proceed to roughly shape up the teeth using for the purpose the largest and coarsest wheel. As a guide to cutting, and in order to give greater confidence in doing so, the outline of the teeth should be pencilled on the block. If irregularity with regard to the relation of the crowns is intended, as for instance the lateral overlapping the central, this should be provided for at an early stage before the incisive edge of the block is thinned down too much. A cut with a thin-edged wheel should be made in

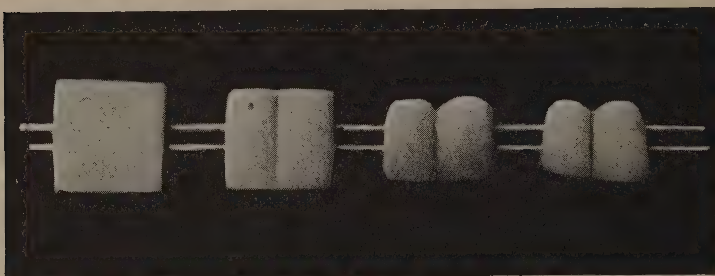


FIG. 125. Stages in shaping up double incisor crown from rod No. 27. Time taken, 30 min.

order to define approximately the width of each tooth, and the groove should be made deeper and wider at the cervical than the incisive border, indeed it should be quite thin and shallow toward the latter. A cut should also be made on the lingual surface of the block approximately defining the width of the teeth on that surface also.

The subsequent shaping up of the labial and lingual surfaces of the crowns will be best carried out by means of the wheels and discs shown (Fig. 126), also Leaming's "Vulcan," carborundum wheels and discs, but the choice of wheels with regard to size, shape of edge, coarseness, etc., must remain a matter of indi-

vidual preference. Care must be observed, however, not to damage the surface of one tooth while grind-

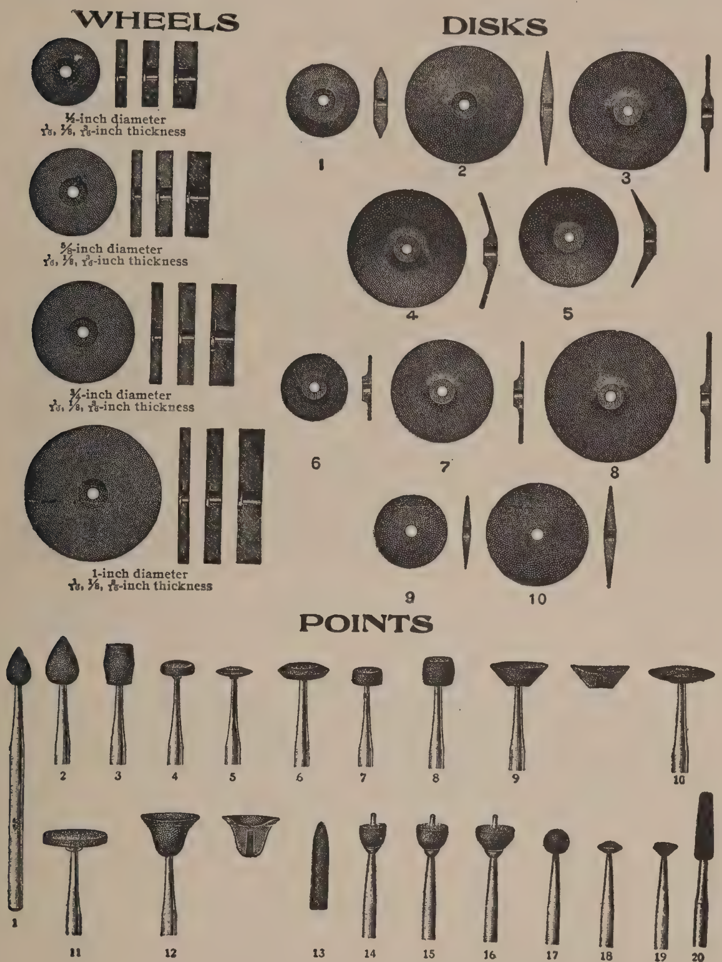
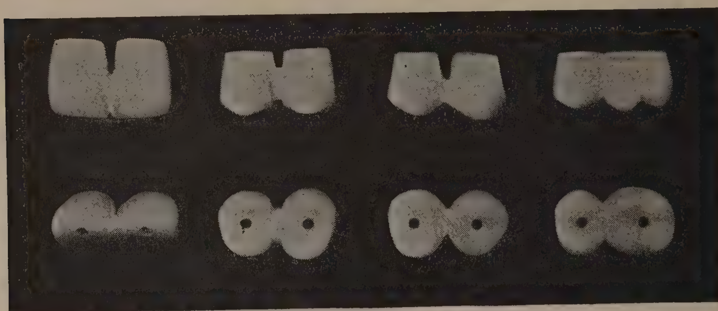


FIG. 126. S. S. W. Vulcarbo Discs and Points.

ing the other. It is of special importance to avoid doing this when defining and deepening the division between the crowns, and at the same time shaping

their approximal surfaces. The S. S. W. vulcarbo point No. 12, vulcarbo disc No. 5, and Leaming's disc No. 508, as well as others by these makers will be found invaluable for the purpose. The copper carbo-cutter No. 4, suggested by Dr. P. W. Smith of Palmyra, N. Y., will also be found most useful used in the manner he suggests, but the sugar solution spoken of will be found more satisfactory in retaining the carborundum powder than will plain water.



A B C D

FIG. 127. Labial and incisive views of teeth cut up from double tube rod No. 32, tubes 8 mm. apart. A, Central incisors. B, Canine and bicuspid. C, Two bicuspids. D, Bicuspid and molar.

The process of shaping up should be continued until the crowns are ready for final touching up at the chair side, or they may be entirely finished. With regard to the time required to fit two crowns shaped up from a double tubed rod, it will be found that in some cases it does not take much longer to do so than in the case of a single crown, for the reason that the two posts permit of the crowns being carried accurately to place without danger of their direction being altered. Fig. 124 shows some of the stages of preparation, and the methods suggested are applicable to all multiple crowns formed from tube rods

of which several examples are shown in Figs. 127, 128 and 129.

The reluctance which has hitherto been shown to do more than the minimum amount of grinding has been due to a number of causes which have been already dealt with, but in spite of their removal,

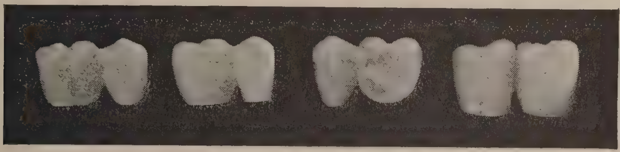


FIG. 128. Buccal views of teeth cut up from rod Nos. 27 and 28.

the disinclination spoken of still persists, and is most marked with regard to the labial surfaces of the teeth, and more particularly with those of the incisors and canines. Long standing custom has apparently decreed that these surfaces must be inviolate, but artistic results in certain cases can only be obtained by abandoning these prejudices. Another factor which appears to militate against the art of tooth

FIG. 129. Shows end view of Fig. 128.

shaping is its supposed difficulty and the wide-spread idea that it calls for exceptional skill and occupies much time, and this mistaken idea might be applied to the shaping up of teeth and crowns from porcelain rods and larger forms of tube teeth. With the view, therefore, of removing these apparent obstacles, the reader's attention is directed to a

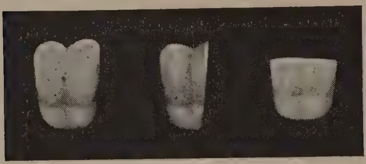
consideration of the following facts, which will be further amplified before concluding a description of the methods suggested for obtaining skill in tooth shaping, and these should be helpful in connection with grinding, shaping, and fitting plain teeth also.

The acquisition of skill in shaping teeth depends upon several factors, some of which will be briefly dealt with. Thus, a thorough knowledge of the surface anatomy of the teeth and the various types to be met with should be part of the ordinary equipment of student as well as practitioner, and it is knowledge which is easily and quickly acquired by the exercise of intelligent observation. Valuable help will be obtained in this direction by gathering together as many specimens of typical natural teeth as possible, and as a further aid towards obtaining "an eye," for tooth forms, it is well to cultivate the habit of outlining the various surfaces of natural teeth by simple outline drawing on paper, and also on porcelain rods, from which the superficial glaze has been removed. It is necessary to realise the importance of paying heed to these observations, because it must be apparent that the absence of the knowledge spoken of must result in much time being lost, in deciding where to grind. It naturally follows then, that the greater confidence one has in knowing where to grind, the more rapidly the desired result will be obtained. Other conditions being equal, the man with artistic instincts and natural aptitude will excel one less fortunately endowed, and will obtain better results. At the same time, these qualities are no more necessary in connection with tooth shaping than in any other department of our work, and the results which follow from their possession

are merely an advantage, not a necessity. Whatever advantage the experienced practitioner may have over the student or beginner will be mainly on account of his greater knowledge of tooth forms, and very little of it will be due to his previous experience in grinding. Indeed, he will probably have no small amount of difficulty in trying to rid himself of certain preconceived ideas and prejudices which will handicap him; and if he has failed to familiarise himself with the shapes of the various teeth, he will doubtless be confirmed in the misguided idea that the mere mechanical removal by grinding of a certain amount of porcelain accounts for most of the time spent in tooth shaping, and he may fail to grasp the important fact that time is lost mainly in deciding where to grind. It has been already stated, and it is worth while repeating, that in order to realise what can be done in the matter of rapid grinding (Figs. 130 and 131) it will be necessary to employ wheels better suited to our purpose than those at present in use, and that for every-day workroom grinding and without special reference to the matter of shaping up teeth or crowns from tube teeth or porcelain rods. It is well worth the practitioner's while to put to the proof the illustrations given regarding the possibilities in the matter of rapid grinding, and for this purpose he is advised to procure a car-

FIG. 130. A and B shows amount ground off rod No. 26 in 1 minute. A, Carborundum wheel used. Size, 4 in. by 3/8 in. Grade K. Grit 80. Vitrified bond. Speed 1200. Note chipping of edge. B, Elastic bond wheel used. Size, 4 in. by 3/8 in. Grit 90. Speed 1200.

borundum wheel, $3\frac{1}{2}$ or even 4 inches in diameter, $\frac{3}{8}$ths of an inch thick, grit 100 or even 80, grade K, L, M, or N,[1] and note the amount of porcelain which can be ground in say 35 to 45 seconds (Fig. 124B). This will bring home to him far more forcibly and in a practical way what can be done in the matter of time saving by the use of suitable wheels, than any amount of writing can do. The art of tooth shaping is so simple that a small amount of practice will enable the tyro to obtain results which will bear comparison with manufactured teeth and crowns, and the apparently crude specimens which he soon learns to produce quickly, have an amount of character which often makes them superior to the more finished article, and this is best seen when they are compared with natural teeth in the mouth. In order to make the comparison most convincing, a further test may be carried out in the following manner: — Select a plain tooth to match a natural tooth in shape, size, and colour, then proceed to shape up a tooth from a porcelain rod or largest size of tube tooth to match as nearly as possible the natural one in shape and size, but without attempting to copy too closely the niceties of outline or detail. In the great majority of cases, the comparison will be in favour of the roughly shaped up specimen, as against the manufactured one. These points deserve



A B C

FIG. 131. A, Shows S. S. W. Tooth, No. 10. B, Shows side ground off. Time, 1 min. Wheel used carborundum, 4 in. by $\frac{3}{8}$ in. Vitrified bond. Grade k. Grit. 100. C, Shows crown ground off. Same wheel used as above. Time 30 sec. The elastic bond wheel used in Fig. 130 would show better results.

[1] See the Carborundum Company's Trade Catalogue.

careful attention and should be put to the test, as the results are likely to prove both surprising and gratifying, and will no doubt encourage the beginner in the prosecution of a delightful and fascinating art wherein excellent results are to be got by means of a very moderate equipment, both of skill, time and material; but there is an additional advantage in that he will feel that he starts more on a level with his seniors in this than in any other branch of our work, because his text books will have shewn him that little instruction has been offered even in regard to fitting teeth or crowns, while the few instructions given in regard to shaping teeth have been confined to suggestions about grinding a little off the cervical and incisive margins of the incisors and canines, and grinding the back teeth in order to obtain a good occlusion.

CHAPTER XI

CROWN WORK

Tube Teeth Crowns without Collars

THE unbanded or collarless crown has always been a favourite, and its growing popularity is evinced by the rapid increase in number of detached-post crowns, most of which are used unbanded. Doubtless the popularity of the latter is partly due to the limited demand which they make upon the skill and time of the operator, to the large selection afforded — indeed, one might say the *too* large selection — and possibly also in some cases to their cheapness. There are, however, very many conscientious and skilful operators to whom some of these advantages would not appeal, but who maintain that the strength derived from banding roots and the additional anchorage thus obtained is neutralised by the increased difficulty in preserving a healthy condition of the gum and pericemental membrane, and for these workers the unbanded crowns provide all the advantages which they consider necessary. There are also many cases which from various causes, such as caries, or fracture of a portion of a root, make the accurate fitting of a band impossible. These cases may be successfully dealt with by means of what is usually known as the plate and dowel, or the unbanded crown.

The preparation of the root with regard to its surface differs from that followed in connection with the banded crown, and should be carried out in the manner shown in Fig. 132A, first described by Dr. C. M. Richmond, and known as the New Richmond Crown. The advantage of this method of shaping lies in the resistance offered to the forward thrust of the crown in the case of the front teeth, to which this method of preparation is alone suitable, resulting as it does in diminishing the strain put upon the post, and transferring part of it to the lingual surface of the root, thus minimizing the danger of fracture, while it also prevents rotation. This method of preparation is not suitable where decay has extended below the gum, unless it is confined to the palatal or labial surfaces only. The cutting-down of the root should extend to about one sixty-fourth of an inch below the margin on the lingual, and slightly deeper on the labial surface, which should be shaped to follow the outline of the gum margin, so that the joint may be perfectly hidden. In this method the enamel should not be removed, and so the preparations should be made by means of small stones, and not with a root-facer, such as the Ottolengui, as thereby there is danger of fracturing the ring of enamel surrounding the root. Assuming that the case about to be described is that of a central incisor, the canal should be reamed out to a No. 2 size Peeso reamer — which is about $13\frac{1}{2}$ U. S. G. wire — and after the apex has been sealed a tapered post should

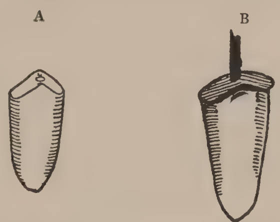


FIG. 132. A, Manner of shaping root for unbanded crown. B, Post and cap in position on root.

be fitted to the canal, and if need be, bent to the line of the cutting edge of the adjoining teeth, and this as a rule can best be done after the impression has been cast. A piece of pure gold No. 28 to 30 gauge should now be cut to conform with, but extend slightly over, the surface of the root, to which it should be burnished. It should then be perforated at the point indicated by the depression, which shows the position of the canal. The end of the post should next be grasped with the roughing pliers, and the point forced through the small opening made in the cap, until the post is home into place (Fig. 132B). A small piece of temporary gutta-percha stopping should next be moulded over the cap and around the post, and post and gutta-percha grasped with pliers and carefully removed; or, if sufficient care be taken, the post and cap may be removed without resorting to the use of gutta-percha, and in consequence the necessity for investing can be avoided. Cap and post should next be united by means of a small piece of solder sufficient only to tack them together, and, after soldering, once more placed on the root and burnished to fit it accurately, while any surplus gold covering the root should be trimmed off. An impression, or an impression and bite with the cap and post in position on the root should now be taken, and this should include one or two teeth on either side. A suitable tube tooth should then be selected and shaped up and ground to fit the cap in the manner previously described, or a porcelain rod may be used if a satisfactory tooth cannot be obtained. Another method by which the cap is dispensed with, and only a post employed is as follows: — Prepare the root in the

manner already described, and fit a post to the canal, when an impression should be taken and a model obtained; next the crown should be fitted to it, and the post afterward cemented into the root when the crown may be fine-fitted to the root. The subsequent steps of finishing have already been dealt with. In place of an ordinary post, a How screw, size B, may be used in the manner described in connection with these instruments.

Another method is to dispense with a model altogether, and shape up the crown directly to the root. This may be done in the following manner: the root having been prepared as already described, the post should be fitted, adjusted, and fixed to place, when a suitable tube tooth should be selected and rough-fitted, care being taken to leave it sufficiently large for fine-fitting to the root in the manner described in connection with the fitting of a front tooth crown to a model; but as no preliminary trimming of the approximal surface of the adjoining teeth is here possible, care must be observed to first fit the tooth tightly into the space. In order to mark the point of contact between the tooth and root, small discs of articulating paper may be employed, or vermilion paint used. The advantages gained by the post acting as a guide to accurate fitting shortens the operation and makes it easier.

Tube Posts. Where it is deemed necessary to employ a tube post instead of a solid one, this may be done as mentioned in Chapter V, page 63.

Unbanded Bicuspids. The method of procedure in connection with the application of a bicuspid crown to an unbanded root differs from that neces-

sary in dealing with the incisors, as the former does not permit of the root surface being shaped in the same way, as thereby the porcelain crown would be unduly weakened and so a saddle shape should be given to the root, (Fig. 133). Should there be two canals, as is usually the case in the upper first bicuspid, a post should be fitted to each. (See description given in Chap. IV, of Fig. 37).

Fig. 133. Bicuspid root prepared for cap.

Unbanded Upper Molars. Here again the general method of procedure closely approximates to that followed in dealing with the bicuspids, though there are necessarily differences in the matter of detail. The palatal root, being the longest and strongest, is best suited for the purpose of carrying the post, which may be bent as in Fig. 134. A better plan, however, is to fit a post to the palatal canal, and a separate one to carry the crown, following the method described on page 53, and taking advantage of reinforced anchorage where this is necessary by shaping the pulp chamber as therein described, or by utilizing the canal of one of the buccal roots. While the bite is usually open enough to allow of sufficient strength of porcelain for both the first and second molars, the third molars, both upper and lower, can rarely be relied upon to afford a sufficient thickness of porcelain for strength, and an all-gold crown is most suitable for them.

Fig. 134. Shows post bent to carry crown.

Crowning Molar Roots which have been Separated by Decay at Their Bifurcation

While it is unusual to meet with this class of case, they are not very uncommon. Hitherto the only method suggested whereby such roots could be made useful has been to cap and band the individual roots, join them together, and on this foundation to construct a gold crown, or to treat them as individual gold crowns. No attempt as far as the writer is aware, has been made to describe a satisfactory method of all-porcelain crown substitution to meet those cases. This doubtless has been due to the supposed unsuitability for the purpose of the various forms of porcelain crowns, though there appears to be no reason why some of these fused on to a platinum base should not have been suggested. Whatever the reasons may be for not doing so, they certainly could not apply to tube teeth, as experience has proved that these are well suited for this purpose, both with regard to adaptability and strength, while they have all the advantages in appearance which porcelain possesses. Ordinarily the lower molars yield better results than do the upper ones, as the difficulties with regard to the latter are increased, owing to the presence of three instead of two roots. The method of application differs from that of a tube molar crown in only a few details, and consists in banding and capping the individual roots, where these are capable of taking their share in supporting a crown, Figs. 135 and 136.

In the case of a lower molar, after the caps and bands have been made, as long a post as is practicable should be fitted to the posterior canal, which usually

affords the best anchorage, and soldered to the cap in the usual way. It will be frequently found that the anteroir root permits of only a very short post, or even none at all, but such anchorage as may be available should be fully utilized. After soldering, the caps should once more be placed upon the roots, and the accuracy of their fitting tested, after which a small plaster impression should be taken of them in position, when these may be replaced in the impression if they do not come away in it. The impression should then be cast in investing material, and the plaster removed after the latter has hardened; next, the caps should be united by means of solder, and if necessary strengthened by a piece of plate. A post to carry the tube tooth should be soldered centrally between the united surfaces of the caps for the purpose of carrying the tube crown (Fig. 135), which should be fitted to the cap and to the bite in the usual manner.

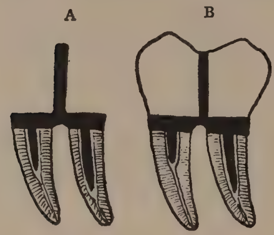


FIG. 135. A, Roots of lower molars capped and banded. Caps joined together with central post to carry tube tooth crown. B, Shows completed crown.

Another method is to solder a vertical post to each of the caps (Fig. 136) and shape up a double-tubed crown from rod No. 28 or 29 (Fig. 136B).

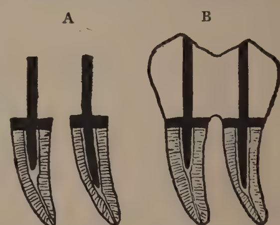


FIG. 136. A, Individual roots of lower molar capped and banded with separate posts in each to carry crown formed from double tube rod. B, Shows completed crown.

Crowning Loose Teeth. The first thought that will occur to the reader will doubtless be that loose roots should not be crowned, and this is doubtless

true in the majority of cases; but circumstances sometimes arise which make this operation not only highly desirable, but necessary, the results being that a root thus treated often has a long period of usefulness.

The expression "loose tooth" is one capable of wide interpretation, and no hard-and-fast rule can be laid down with regard to the degree of looseness which will warrant crowning. Consequently, the choice of such cases as are likely to prove successful is one which each operator must decide for himself, and in doing so many important factors will call for consideration, such as the age of the patient, the cause of the loosening, the probability or otherwise of the tooth responding favourably to treatment, the amount of support obtainable — usually a necessary adjunct to success — and lastly the skill in carrying out the various steps in the operation.

Ordinarily, the joining together of two or more loose roots increases their individual chance of usefulness, and favours such therapeutic measures as are adopted with a view to this end, and these results also necessarily follow when a loose root is anchored to a firm one, with the result that such loose roots usually attain a remarkable degree of firmness, owing to the consolidation of old bone and deposition of new. The principle may be further extended to include a large and important class of cases, in which a number of loose teeth may be splinted together to afford a foundation for one or more tube teeth. For descriptive purposes, then, the two following types of cases will be selected: —

(1) That in which two or more loose teeth or roots are joined together; and

(2) That in which a loose tooth or root is anchored to a firmly implanted one either by means of a crown, bar, or inlay.

With regard to the first class, assuming the case to be that of a loose second bicuspid which is to be joined to a loose molar, the caps and posts should be made as for single crowns, adjusted to place, and a small plaster impression taken in the usual way. This should be cast in investment material in order that the parts may be maintained in their exact relationship. After they have been soldered together, they should be replaced on the roots in order to make certain that their relationship has not been disturbed. A small model and bite should now be taken and the caps removed and placed in the impression, the model and bite being cast in the usual way. The remains of each of the posts projecting above the caps should then be cut off, and separate posts soldered as for individual tube crowns or two tube crowns joined together and formed from porcelain rod No. 30, 31, or 32 may be used (Fig. 137). The crowns should now be fitted and shaped in the usual way, the final touches being given at the chair side.

A B

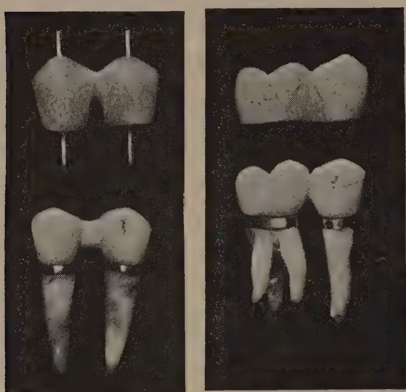


Fig. 137. A, Shows molar and biscupid crowns shaped up from tube rod No. 32. B, Shows two bicuspids shaped up from tube rod No. 31.

Opportunity may be taken here to point out that no difficulty need be experienced in obtaining paral-

lelism between the posts where two or more crowns are formed from a tube rod or tube blocks when the posts are used vertically as in these illustrations, as the tube rod is a certain guide to the direction of the posts. Later on it will be seen that ample provision is made for adopting a similar simple means of obtaining vertical parallel tubes when tube rods are used horizontally in bridge work, and that the special appliances which have been devised for the purpose of obtaining parallelism are unnecessary.

With regard to the second class, where a loose root is to be anchored to a firmly implanted tooth, and assuming once more that the case is that of a loose upper second bicuspid root, which is to be joined to a firmly implanted molar, in the crown and approximal surface of the molar which is to furnish the supplementary anchorage, a suitable cavity should be prepared for the reception of an anchorage bar or a gold inlay. Not infrequently this will call for devitalization of the molar pulp, but very often a filling or cavity is present, and when this is the case advantage should be taken of it. Figs. 138 and 139 show a method of attachment which will be found suitable for most cases, and consists in soldering a supplementary post to the edge of the cap and band, and bending it to fit into the cavity of the tooth. For this purpose a model and bite will be necessary to enable the anchorage wire or bar to be fitted, and this and the central post for carrying the crown may be soldered to the cap at the same time. The

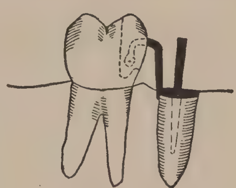


FIG. 138. Shows method of attachment by supplementary post into filling.

tooth afterwards may be fitted to the cap in the ordinary way, a groove being cut in its distal surface for the accommodation of the bar, which may be of half-round instead of round wire; or the crown may be fitted first to the cap and a groove then cut in its approximal surface into which a round or half-round wire may be fitted and afterward soldered to the cap. The supplementary or firm anchorage tooth may sometimes require to be crowned by means of

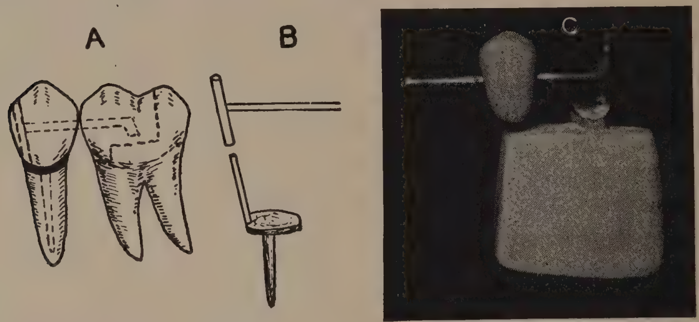


FIG. 139. A, Bicuspid tube crown formed from rod No. 24 with the tube horizontal. The root is capped and banded and post is soldered on anterior edge of cap to enter tube soldered to horizontal bar as shown in Fig. B. C, Shows the constructional details of a second lower right bicuspid.

an all-gold crown, when their union should be carried as near their occlusal surface as is consistent with sufficient strength. By this means the interproximal space will be least interfered with.

Supplemental Anchorage. This is necessary where there has been extensive recession of the gum followed by decay low down on the buccal surface of a tooth, as for instance in a second lower bicuspid (Fig. 140A). Here the exposure of the root with subsequent decay prevents the use of a sufficiently long post in the root, and so a supplemental anchorage becomes necessary. The tooth should be capped

and crowned as described; then form an inlay for the cavity in the molar and extend it to form a spur to rest in a deep recess hollowed out in the grinding

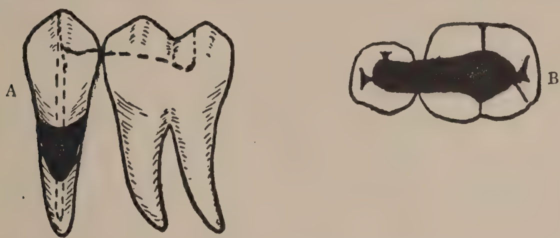


FIG. 140. A, Shows lower bicuspid with insufficient length of post in canal. Supplemental anchorage is obtained by inlay in crown of molar extended on to recess in bicuspid tube crown as in B.

surface of the tube crown extending to the post, the inlay being permanently cemented into the molar (Fig. 140B). Along with the disadvantage spoken

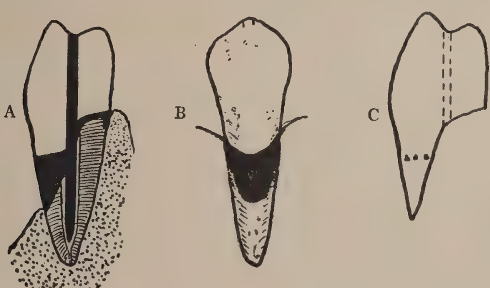


FIG. 141. A, Shows gold cap built up on buccal surface in order to avoid undue thinning of porcelain on cervico-buccal surface of tube crown. B, Shows buccal view. C, Shows excessive thinning of porcelain.

of in connection with insufficient anchorage obtained by means of a post only, the cervico-buccal portion of the porcelain crown is apt to become unduly thinned, and so weakened, particularly when the difference in level between the lingual and buccal

margins is great. Under these circumstances the gold cap may be thickened up on its cervico-buccal surface, to which the crown should be fitted, and when finished the gold will appear as a cervical filling (Fig. 141).

The Application of a Porcelain Shell Crown to a Tooth with a Living Pulp

While the majority of practitioners favour devitalization of the pulp in all but a very limited class of cases, there are some who for reasons which they consider good prefer to conserve its vitality, particularly in the case of the incisors, both upper and lower, whenever it is practicable to do so. The reasons advanced for preserving vitality need not be fully entered into here, but that it is sometimes advisable and indeed necessary to do so is beyond dispute. Among the most common cases which require this treatment are certain forms of malformation of the crowns of incisors, such as deficiency of the enamel or extensive abrasion, partial or complete calcification of the pulp, whereby its devitalization and subsequent removal might be rendered difficult or impossible without the risk of perforation. The age or physical condition of the patient may also be an important factor in deciding against any attempt being made which would involve possible pain or tend to prolong the operation; also certain cases of malformation of the root which might preclude the employment of a post. Quite a number of methods have been suggested for treating such cases, and these consist mostly in applying the principle of the jacket crown in combination with a porcelain facing. But all of these plans are open to certain objections

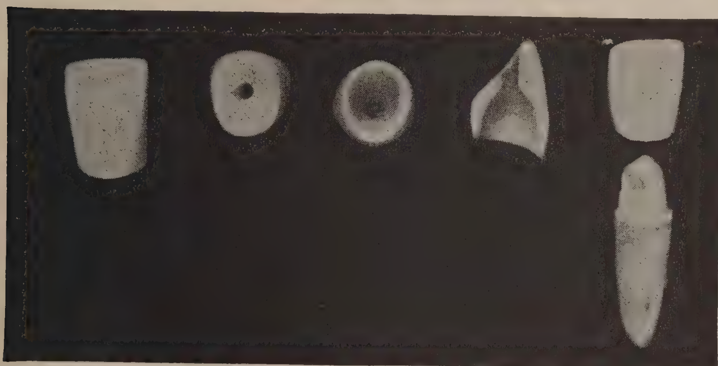
either on account of lack of strength, excessive bulk, unsightliness, or difficulty of construction, and most combine one or more of these objectionable features. The method of applying a jacket crown with a porcelain face, the incisive edge of which is strengthened by means of clasp gold and solder with a view to protecting the porcelain is unsightly, unnecessarily bulky, and not much superior in point of appearance to that most objectionable creation an all-gold crown. If the protection of the incisive edge of the porcelain in the manner described is dispensed with, there is danger of fracture. The application of several of these forms of shell crown has recently received a considerable amount of attention, and has not a few advocates. The manner of their construction is usually as follows: The remaining natural crown is shaped up to admit of the accurate adaptation of a platinum jacket or cap of No. 60 foil, burnished to it, or of No. 36 soft platinum plate employed in the same way, or a die may be used to swage it. A very thin facing is ground to proper adjustment, and the pins soldered to the cap, when the crown is completed by fusing a sufficient quantity of body over it. Obviously such a form of crown is lacking in the first essential, namely, strength — because, as has been already pointed out, fused porcelain, even when supported by a platinum shell, is much too weak. In order to minimize this, the use of high-fusing body is suggested, and doubtless in the hands of the expert this may yield good results in certain selected cases, but for those who have little experience of porcelain work, the method is unlikely to afford the results expected. Therefore, the foregoing objections to the use of fused porcelain

appear to impose a sufficient barrier to further extension of its use in this direction, unless a variety of porcelain can at some future time be produced which is free from the defects already mentioned. Such a contingency, however, seems remote, and probably our energies would be much better employed in an endeavour to improve the quality of fused porcelain with regard to strength and colour, and do away with the equally serious disadvantages imposed by its excessive liability to shrinkage. Meanwhile, it is hoped that advantage will be taken of the means at our disposal in connection with tube teeth and porcelain rods, as these yield all the advantage claimed for fused porcelain and in a manner of which the latter is incapable. There remains, too, the question of time, and as the methods spoken of call for more than an ordinary amount of this, a simpler and better plan will doubtless commend itself. This we have in the use of the tube tooth, which calls for no special skill beyond that required in ordinary prosthetic work. It is proposed, then, to consider some of the methods wherein the employment of these teeth has been proved to yield highly satisfactory results. In the case, say, of a central incisor, the labial surface of which is extensively denuded of enamel, the crown of the tooth should be shaped up as in Fig. 142, the preparation being carried to the gum margin or a little beyond it, and following the festoon of the gum. Generally speaking, the whole of the enamel should be removed by means of carborundum wheels and points. This operation may be carried out with little or no pain

Fig. 142. Tooth prepared to receive porcelain shell crown.

in the following manner, which, it may be remarked in passing, is also an invaluable method with some slight modifications, of opening into an acutely inflamed pulp.

Place the tube of the saliva ejector in the mouth, and have the assistant direct the stream of water continuously upon the tooth, commencing with a syringeful, about 60–70 degrees, and quickly change to one about 10 degrees lower and follow with one of



A B C D E

FIG. 143. A, Central incisor tube tooth. B, View of base. C, Base hollowed out. D, Section showing part hollowed out. E, Finished tooth with root. Time taken to hollow out base of crown 6 min.

ice-cold water, continuing with this during the shaping up process. In this manner all pain is avoided.

It is not proposed here to enter into further details with regard to the shaping up process. This is familiar to those in touch with modern methods of crown work, and so the method of procedure in connection with fitting and shaping a crown from a tube tooth or section of porcelain rod will now be dealt with. The general plan is as follows: If the tooth is an isolated one then no model is necessary, as the crown may be fitted directly to the shaped up

tooth. Having selected a suitable tooth of the right colour and of ample size, proceed to enlarge the tube at its base, and in order to do so employ the coarsest grit of carborundum point mounted in a porte-polisher. Place the tooth in a rubber cup filled with water, base upward, and, with the engine run at a high speed (see Chap. X, p. 171), hollow out the base (Fig. 143c). Ordinarily it will require to be shaped as in Fig. 143D, and Fig. 144 so a rotary motion should be used to deepen the recess. This takes only a few minutes; in fact, the average time taken to hollow out is about five minutes. The shaping up and polishing, however, may take anywhere from twenty minutes to an hour. The latter should be ample even when the largest size of tube tooth or porcelain rod is employed. If need be, small wheels may be used to enlarge the recess still further. The eye alone will serve to gauge very nearly the amount which should be ground out. The crown may then be tried on and points of contact noted and ground off until an accurate fit is obtained. To facilitate this, paint may be used to mark the points of contact. Having obtained an accurate fit, proceed to shape up the tooth to the desired size, and form in the manner described in Chapter X.

Fig. 144. Shows molar shell crown formed as in Fig. 143.

Another method is to take an impression, fit the crown to it, and fine-fit at the chair side.

The strength of the anchorage of the crown to

the tooth, and the strength of porcelain thus obtained is greatly in excess of that got by any of the other methods described as the ground recess, affords the maximum amount of hold for the cement, while the porcelain, being manufactured, greatly exceeds in strength that of the fused porcelain crown. In consequence, a much thinner porcelain shell may be used. Moreover, the final shaping up of any or all of the surfaces of the crown may sometimes be done after it is set on the tooth, and the polishing carried out by means of the smoothing wheels previously spoken of and felt or moosehide buffs, with pumice and water.

The Jacket Crown with Tube Tooth. If a single tooth only requires to be crowned, that portion of it standing above the level of the gum should be cut down to within about $\frac{1}{16}$ of an inch of the gum on the lingual and level with it on the labial surface, the periphery of the root trimmed, and a band and cap formed in the usual way, the former being made of 22-carat platinized gold No. 30 gauge. The post should be soldered as near the front as possible for uppers in order to obtain the maximum strength of porcelain (Fig. 145), and this may be done by using a tube tooth or section of porcelain rod of sufficient size to cover the cap, at the same time allowing the post to be placed where it will least affect the strength of the crown. Usually this will be near the labio-cervical border. Even a very short pin will permit of ample anchorage of the crown to the cap. Indeed, the rough surface left by grinding the base gives in it self remarkable adhesion, especially when the gold is also roughened. Attention at this point

Fig. 145. Post soldered anteriorly.

is once more drawn to the fact that the better the fit of porcelain to cap, and of post to tube, the more secure the attachment. The statement so persistently made by so many writers that a considerable body of cement adds strength, is entirely erroneous, is contrary to the facts of experience, and is also negatived by the argument — undoubtedly a sound one — applied to inlays, wherein it is maintained that the smaller the body of cementing material, the more secure is the attachment. In these cases where two or more adjoining teeth require crowning at the same time, greater strength is obtained when these are shaped up from a double-tubed porcelain rod (Fig. 146) than when individual crowns are employed.

FIG. 146. Central incisors formed from double tube rods. A, Approximal surface. B, Lingual surface, C, Labial surface.

Double Shell Crowns. These may be made by applying the principle and adopting the plan shown in Fig. 143, whereby a section of double tube rod may have the base of each crown hollowed out to afford anchorage. Fig. 147 shows two central incisors so shaped from rod No. 30, with tubes 5.5 mm. apart. The foregoing method may be applied for the replacement of a pair of detached or fixed-post crowns, the renewal of which from some or any cause may

FIG. 147.

necessitate this, and where it is undesirable to attempt removal of the existing anchorages, Fig. 149. Thus, for instance, it may be employed for the replacement of one or two Richmond crowns, by grinding off the metal backings and leaving the posts standing sufficiently high to afford the necessary anchorage, or for joining together two loose roots. Figs. 150 and 151 show a further extension of the principle where it will be seen that one root is missing.

Fig. 148. Shows double shell crowns. Lateral and canine shaped up from rod No. 30.

Crowning Lower Front Teeth. While an almost endless variety of methods have been suggested for crowning all the teeth in the upper jaw and the grinding teeth in the lower, there is a remarkable dearth of literature on the subject of crowning the lower incisors and canines; moreover, little provision is afforded for selection in the matter

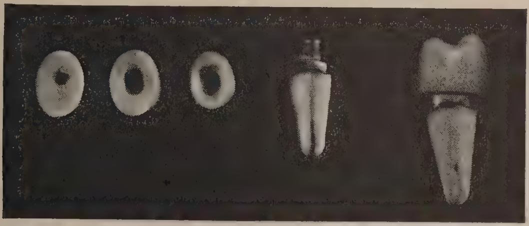


Fig. 149. Shows method of replacement of broken Richmond or other post crown by a tube crown.

of either fixed or detached-post crowns suitable for this purpose. To judge from the absence of criticism with regard to this deficiency, one would assume that the necessity for crowning these teeth seldom arises. While it is true that one meets with far fewer cases in

the lower than in the upper jaw, and that it would be difficult to state with accuracy the proportion which these cases bear to those of the upper incisors, it is probably fairly near the mark to say that the proportion is somewhere about 1–10. At all events, they are sufficiently numerous to call for more attention than seems to have been given them. Such methods of crowning as have been suggested have been concerned mostly with the use of the banded crown with porcelain face; where the bite is close, it has been boldly suggested to employ all-gold crowns as previously mentioned. As these have been the chief methods suggested it seems reasonable to suppose that they have been advanced because it has been taken for granted that no other method which would combine the necessary strength with æsthetic requirements is available, and in the absence of the tube tooth this fact is undeniable. These, however, meet all requirements either when employed as single crowns or when conditions permit of two or more being shaped up from a porcelain rod, and the advantage gained in strength is even more marked than in the upper, (Figs. 152 and 153).

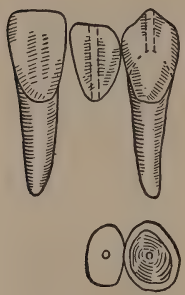


FIG. 150. Canine porcelain shell crown with lateral incisor extension.

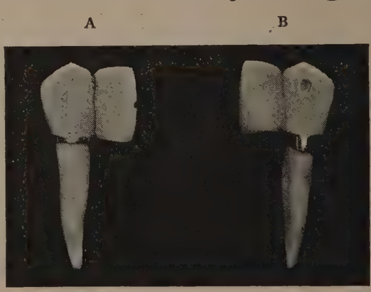


FIG. 151. Extension of principle shown in Fig. 149 and 150.

The method of employing them is precisely the same as in the case of upper incisors. With regard

to these lower tube teeth, they are generally too small in the base to cover a banded root, but when this is the case a suitable one may be readily formed from one of the larger forms of tube teeth, or from a tube rod. The canal should be enlarged with the small special size of Peeso reamer,[1] and enlarged at its proximal end with No. 1 reamer; owing to the thinness of these roots, it is generally desirable to employ a full band, and that part of the post

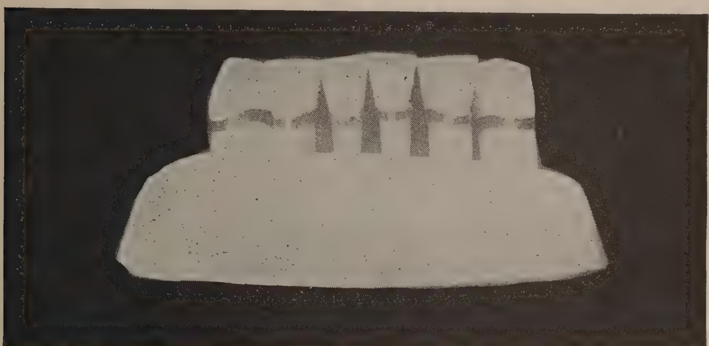


FIG. 152. Lower Incisor Tube crowns.

which enters the canal should be tapered from its junction with the cap.

Tube Crowns in Abrasion and Erosion. The application of tube crowns in cases of extensive abrasion and erosion calls for fuller consideration, as these cases are of frequent occurrence. The causes which give rise to this condition are numerous, and among the most common is faulty occlusion resulting from early malposition of the teeth. When this occurs it is nearly always associated with an edge-to-edge bite, which tends to become aggravated with advancing years. The number of teeth involved, also

[1] See page 812 of the "Dental Cosmos" for July, 1914.

the character and extent of the wearing-down process is subject to wide variation, and is hastened by loss of the grinding teeth; as a matter of fact this is one of the most common exciting causes of abrasion and of the conversion of a normal bite into an edge-to-edge one. The etiology, however, need not be considered further, but consideration given to the subject of treatment.

When the conditions are similar to those dealt

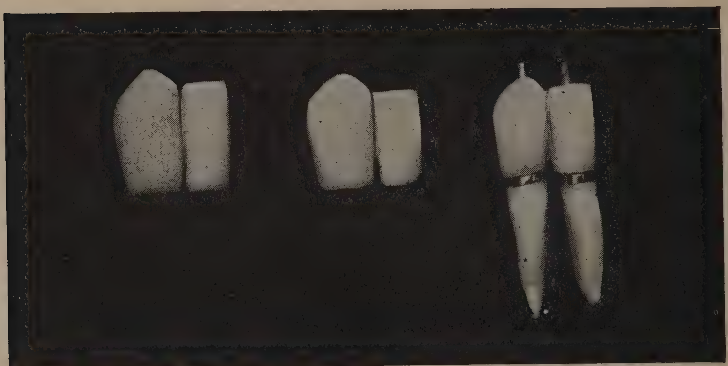


FIG. 153. Shows three stages in shaping up and fitting lower front tooth crowns from rod No. 28. Time $1\frac{1}{2}$ hrs.

with in connection with the crowning of living teeth, the methods therein described will be found applicable, but when it is possible to devitalize the pulp and utilise the root for the purpose of obtaining anchorage, this should be done. Usually the bite requires to be opened, either by crowning, crowning and bridging, by means of plates, or by a combination of these methods in connection with the grinding teeth, in order to obtain sufficient length and strength of porcelain for the incisor crowns.

The number of crowns which require to be in occlusion in order to maintain a sufficiently open

bite, a sufficient grinding surface, and at the same time afford a reasonable prospect of maintaining these conditions for a number of years, will depend on a variety of circumstances, such as the age of the patient, the nature of the teeth, and whether the roots are long and firmly implanted. And it is surprising what permanence may be obtained in this way by crowning the incisors, canines, and bicuspids alone, without the help of the molars or of plates. Indeed, in many cases the patient refuses to consider wearing the latter, even after being fully warned of the diminished period of usefulness these crowned teeth are likely to afford in consequence of the absence of such a valuable adjunct. Here the condition spoken of is not infrequently made the excuse for employing porcelain-faced crowns strongly reinforced with gold at their incisive edges for the upper teeth, while it is sometimes boldly suggested to use all-gold crowns for the lower incisors, and with far less reason than where devitalization cannot be resorted to as where this is done ample strength may be obtained by the employment of tube teeth even in the case of a very close bite. Moreover, additional strength may be obtained where two or more crowns are shaped-up from a porcelain rod (Fig. 154).

Crowns with Exaggerated Contour
Cantilever Crowns

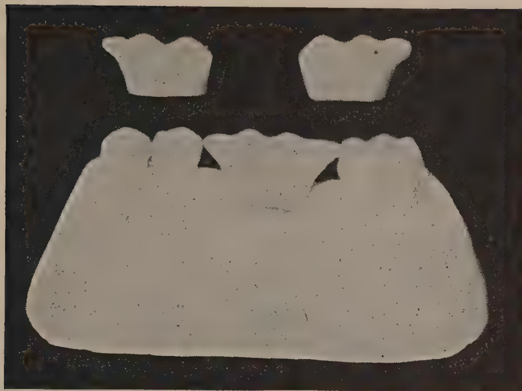
Cases not infrequently occur in which it is desirable to exaggerate the contour of a crown on one or both of its approximal surfaces, and the necessity for this usually arises from the loss of one or more grinding teeth adjacent to the one which requires

crowning. Where the space is too large to be filled by one of the many forms of porcelain crowns, the difficulty is generally met by employing an all-gold or porcelain-faced crown, contoured on one or both of its approximal surfaces until it is in contact with the tooth on each side, in order to prevent food from packing down on to the gum, or to prevent the teeth on each side from tilting towards one another. The largest forms of tube teeth and porcelain rods, especially double-tube rod No. 29, are pre-eminently suited to meet such cases, and in a much more satisfactory way than by any other means. The built-up porcelain crown is seldom strong enough, while the length of time necessary for its construction also tells against it, and the all-gold crown is often unsightly. The tube tooth and porcelain rods, on the contrary, may be utilised for such cases in a great variety of ways, and fulfil the necessary requirements both with regard to strength, adaptability and appearance, in a manner which leaves nothing to be desired (Fig. 155).

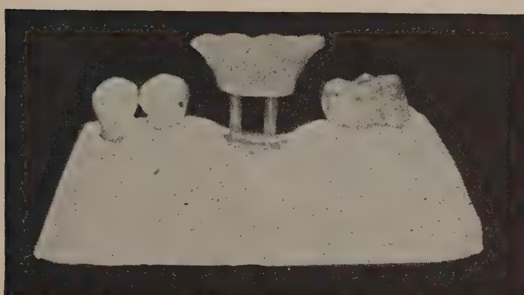
FIG. 154. Case of edge-to-edge bite. The upper central, lateral, and canine of each side is formed from block No. 33. The lower incisors and canines are single tube teeth crowns.

Partial Crowns. Figs. 156A, B, C, show a method of dealing with a case of extensive decay in a molar by means of a partial crown formed from a

B C



A



D

E

FIG. 155. Cantilever or extension crown formed from double tube rod. A, Crown with double extension. B, and C, Anterior and Posterior single extension crowns. D, Method of attachment of crown to cap. E, Coronal view of a lower molar formed from a double tube rod. (extra long antero-posteriorly) to fill large space, such as in A, but where the roots are missing. Bars partly withdrawn showing inlays which are sunk in the porcelain crown.

tube tooth or section of a tube rod. Such cases are fairly common, and the usual method of dealing with them is either to build them up with amalgam, by means of a large gold inlay, or to crown them. All of these methods are more or less unsightly, except the last, and the last only is free from this fault when an all-porcelain crown is used, while there may be objections to the employment of an entire crown. It is here that the partial tube crown fre-

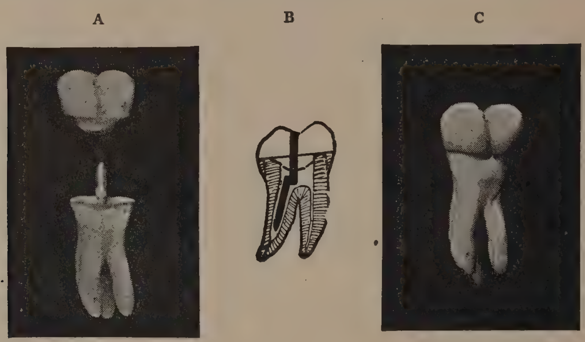


FIG. 156. Shows partial molar tube crown. A and B, Show method of construction. C, Finished crown.

quently proves invaluable. The method of forming it is extremely simple, and is as follows: The pulp, if alive, should be devitalized, all decay removed, and the buccal canals filled. The apex of the palatal canal should be sealed after the canal has been reamed out to take a post of suitable size. An additional, though shorter post, may be used in one of the buccal canals. The approximal, buccal, and lingual walls of enamel should then be ground flat across. The posts should then be placed in the canals, and an impression and bite taken in the usual way, the posts being replaced in the impression before it is cast, if they have not come away in it.

Before proceeding to fit the tube crown, the post should either be bent so that that portion of it which is to carry the porcelain crown is parallel to the long axis of the tooth, or a separate post should be soldered to the post entering the canal (Fig. 156c). An alternative method is to cast an inlay to fit the enlarged pulp chamber, or to swage it, and solder posts and inlay together. The porcelain partial crown should then be shaped up and fitted to the model, and when finished cemented to place.

The Treatment by Crowning of Upper Molars in which the Palatal Root is Partially Exposed

These cases are probably more commonly met with in the first than in the second molars, and the difficulties encountered in treating them successfully, and of obtaining results commensurate with the amount of time and skill employed has received less attention than the importance of the subject appears to warrant. The method of dealing with those cases is almost invariably by means of an all-gold crown, and there are few cases in which an all-gold crown shows to less advantage. Besides, there is the difficulty of obtaining an accurate fit, and the liability to further recession of the gum. The latter inevitably follows sooner or later, and in consequence these cases are looked upon by the skilled crown worker as among the least successful of his efforts. By means of the tube tooth, however, highly satisfactory results may be readily obtained from the artistic, mechanical, and other points of view. Hitherto, no porcelain crown has been manufactured which will meet the needs of such cases on account of the fact that they lack a sufficient size

of base to cover the roots and extend and supply the lost tooth structure. Even the largest of the special forms of tube teeth or single-tube rods is sometimes too small in the base to permit of sufficient material for the purpose. A section, however, from one of the double-tube rods No. 26, 27, or 28 admirably meets the needs of such cases. Probably No. 28 will, on the whole, be found most useful. In preparing the roots, their surfaces should be ground level with, or a little below the gum margin, as long and stout a post as the case will permit of should be fitted to the palatal canal, and a shorter one into one of the buccal canals. The pulp chamber may also be utilised for the purpose of adding to the available anchorage. The enamel should not be removed from the periphery of the roots, as the crown should ordinarily be a bandless one; the cap should be of gold either cast, swaged, or burnished to the surface of the root, and the posts which enter the canals are to be attached to it by soldering. In the case of a cast base, the union of the posts to the base had best be made additionally secure by soldering, unless the posts are of cast metal also, a method to be deprecated. After the base has been adjusted to the model, a section of tube rod should be rough fitted to the surface of the cap and to the form of the crown, and the posts adjusted and soldered in the manner already described (Fig. 157).

Repair Facings. Incidentally it may be pointed out that grinding under water opens up possibilities which it is to be hoped will facilitate many prosthetic operations, such as forming a repair facing from a plain tooth, which may with advantage be employed in place of the S. S. White long-pin

teeth, or other mineral facing, for dental repairs (Fig. 158). A duplicate of the latter can be shaped up in the following way in about five minutes: Select a suitable flat tooth and cut off the pins and grind flush with porcelain. With a very small carborundum wheel, No. 185 or No. 162, cut a groove

FIG. 157. Shows method of crowning upper molar where the palatal root is partially exposed.

in the centre of the back of the facing, deepening and enlarging it by means of a flat-ended porte-polishing point, medium grade. To obtain the necessary undercut, employ an inverted cone carborundum point No. 212 fine grit, reduced to about half the size. These facings are invaluable for repairs to bridges and crowns, and, in fact, in all cases in which a plain tooth has to be replaced. Of course, the remains of the pins are left in the backing, and the facing is simply cemented to place. Small suitably shaped inverted cone points for use in the manner described may be quickly formed from a carborundum point for use with the porte-polisher.

FID. 158. Repair facings.

Repairing and Replacing Tube Crowns. In the chapter dealing with the superiority of the tube tooth, it was pointed out that among the many advantages possessed by tube teeth was the readiness whereby they lend themselves to replacement in the event of fracture. In addition to this, they have the unique advantage of being easily and quickly adapted to any other form of detached-post crown, both with regard to external form and basal anchorage.

Replacement of a fractured "tube crown" may be carried out in one of several ways, and without disturbing the anchorage post. In the case of a front tooth, after all fragments of porcelain have been removed, the most suitable crown should be chosen and fitted directly to the surface of the root or cap, as described in connection with fitting a tube tooth crown directly to a capped root, or a small plaster impression may be taken in the ordinary way, except that a section of tubing (Fig. 159) which will accurately fit the post, and which should have one or two small tags soldered to it, should be placed on the post before the impression or the impression and bite are taken. These tags aid in retaining the tube in the impression while it is being removed, or facilitate its replacement should the impression break or require to be broken during its removal. After the impression has been taken, a suitable length of wire — which may be of brass or German silver, as may also the tubes spoken of — should be placed in the tube, which it should fit accu-

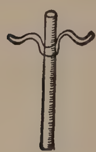


Fig. 159. Tubing with tags soldered to it.

rately, and the impression may then be cast. This will yield a model which will represent the relation of the post to the root, and act as a guide in fitting the crown to the model. Where replacement is required of a section of two or more crowns formed from a double tube rod, difficulty may be experienced in removing the broken portions unless the proper method is followed. This consists in cutting grooves by means of a thin carborundum, diamond, or vulcarbo disc, both labially and lingually, and when these are fairly deep a flat chisel-shaped instrument should be inserted, and with a twist the partially divided portions may be broken off. All débris having been removed, a metal tube should be placed over each post, and the impression taken as already described. The selection of a suitable rod will present no difficulty with regard to the position of the tubes for the posts, for, as already pointed out, these rods are made with the tubes in seven positions, 1, $1\frac{1}{2}$, $2\frac{1}{2}$, $3\frac{1}{2}$, $5\frac{1}{2}$, $6\frac{1}{2}$, and 8 mm. apart, and practically only the last three are used for forming double crowns. A simple method which will meet the requirements of all cases of replacement of single or double detached post crowns is described in connection with Figs. 143, 144, 146, 147 and 148, where it will be noted this can be very quickly done by means of a Butler's point, grinding under water (see Chap. X, p. 171) and the time necessary to do so will vary with the amount of porcelain to be removed; it should not exceed two to five minutes. Such a recess allows of an ample bulk of cement, a point persistently advocated by most men, but not favoured by the writer for reasons already given.

Concluding Remarks on Shaping Crowns. Along with some of the illustrations shown in connection with these papers, a record is given of the times[1] taken to shape up crowns and bridges in various stages, and from these, and what has been already said, the reader should be able to form a fair estimate of the amount of time necessary for the average case. It is hoped that he will conclude that the amount of time and labour necessary for shaping up tube teeth from larger forms of the same, and from the special varieties of single and double tube rods, is not so great as would at first appear. Before concluding the subject it seems desirable to direct attention to some points which have not yet been considered, and to restate others in order to permit of a more just comparison being made between tube teeth crowns and other forms of crown work, and this necessarily involves reverting to the question of time. Possibly, in connection with artistic work this should not be given much prominence, but as men are frequently deterred from adopting new methods because they fear they may involve too much time and labour without adequate reward, the subject is once more brought forward in order to confirm what has been already said with regard to the advantages in the matter of time saving, as this is a factor which has always been considered of such importance that it often acts as a deciding element in the choice of a system for general use,

[1] The reader will note considerable differences with regard to these times. This arose from the fact that the specimens were prepared by individuals with varying degrees of experience; some were prepared by a mechanical assistant and by pupils who had had little experience or none at all, some by a mechanic who had had a good deal of practice, while others were prepared by the writer and his partners.

or in individual cases. But the tube crown has other and more important advantages, though it has no reason to fear comparison with other crowns in the matter spoken of.

Consideration is rarely, if ever, given to the question of time spent over the selection of a suitable porcelain crown or facing, and if this were done the reader would be surprised to find what this amounts to, and the comparison it bears to the total amount of time spent over the operation. If the selection is a large one the time usually taken to make a suitable choice is in proportion to the selection offered; while if the selection is a poor one there is little chance of finding what one requires. On the other hand, it may mean, and very often does mean, sending to a dental depot which involves loss of time and possible disappointment, as few if any establishments of this kind carry a stock of even half the different crowns on the market. Moreover, a small number if any, of these can be adapted to any form of anchorage other than that for which they have been originally designed. The balance, then, is usually much in favour of the tube tooth and porcelain rods, as only a few varieties of these in different shades enable us to meet all cases, because, as we have already seen, the question of size and form are of little moment. The additional time, therefore, which is generally necessary for the selection of other forms of porcelain crowns or facings, may reasonably be deducted from the time taken in shaping up the tube tooth, and a fair margin is ten minutes.

Then, as to the question of skill in its relation to the time mentioned, a moderate amount of experi-

ence should suffice to enable the time given in connection with the illustrations in Chapter X to be equalled, while the least experienced should easily be able to roughly shape up any crown in ten minutes to conform as nearly to a natural tooth as any form of ready-made crown or facing. Failure to obtain these results will not prove that the time given is not ample, but that the fault is in the inexperience of the operator.

Further as to the matter of the correct shaping up of a crown, this does not call for more than an elementary knowledge of the anatomical forms of the teeth, and it is doubtful if there is a better means of acquiring this than by the method suggested.

With regard to the double tube rods, it is to be observed that more time is generally required to shape up two or more crowns from these than is necessary to form a like number of single crowns, but this arises not from the time which is spent in grinding a given bulk of porcelain, but from the care required, and from the necessity for resorting more to the smaller sizes of wheels. And this will be apparent when it is remembered that the relation of the individual crowns to each other has to be kept in view from the first, and maintained throughout the shaping up process, as failure to do this may result in having to commence the work over again. Still, the time taken, even if it extends to an hour — and it should not exceed this period — will be made good in subsequent steps. The fitting of these double crowns to their base takes a little more time than for a single crown, and an ample allowance for fitting is one hour, including the time required to resolder a new post in place of the one which, as formerly

pointed out, it is generally necessary to remove for the purpose of rough-fitting. It has been pointed out that one of the points of superiority realised with the tube tooth over other forms is the readiness whereby its tube may be altered to conform with the anchorage of any other type of crown, and that in this it holds a unique place, as practically all forms of detached post crowns are suitable only for that form of anchorage for which they are intended — and the time necessary to make such alteration falls to be stated here. Experience has proved that a tube tooth may be thus converted to the form of anchorage of an S. S. White or other form of detached post crown in a few minutes by means of carborundum points; at all events, to such form of anchorage as will enable replacement to be made without sacrificing strength, appearance, or utility.

A knowledge, therefore, of the time necessary for carrying out these alterations is a matter of considerable moment, as it may be much quicker and more satisfactory to adapt a tube crown than to send to the nearest depot in the hope of getting what one requires provided one has not a duplicate crown at hand.

The writer believes that the following comparison regarding the time necessary to select and prepare for setting the crowns named will be found a fair one, and for this purpose a central incisor crown has been chosen. The time required to form and unite together a cap, band, and post, is practically the same for all forms of front tooth crowns, and this will not be taken into consideration in making the comparisons; moreover, an impression and bite are not always necessary in the case of either

a detached post crown, or a tube crown, although a model, and usually a bite, are needed for a gold collar crown with porcelain front, commonly called the Richmond crown.

	S. S. White D. P. Cr.	Richmond	Tube
	Min.	Min.	Min.
Selection of suitable crown, say.......	15	15	5
Shaping up crown, say...............	–	–	5–15
Fitting crown.......................	20	10	20
Backing, soldering, and cooling........	–	45	–
Finishing gold......................	–	25	10[1]
	35	95	40–50

The balance, then, is in favour of the detached post crown, which takes less than half the time required for a Richmond crown, while the tube crown takes a few minutes longer than the detached post crown. While the foregoing is only an approximate estimate of the length of time required, as individual skill varies, the proportion which the individual times bear to one another are very nearly correct.

Sufficient, then, has been said regarding the matter of time saving, and it is hoped that the other advantages spoken of, some of which are much more important, will result in commanding the attention to tube teeth and porcelain rods which they deserve. The arguments which have up till now been advanced in favour of tube teeth crowns, have been based on the assumption that a good deal of grinding and shaping would be required and that the work would be done by the operator himself. These two factors need not be operative, and in their

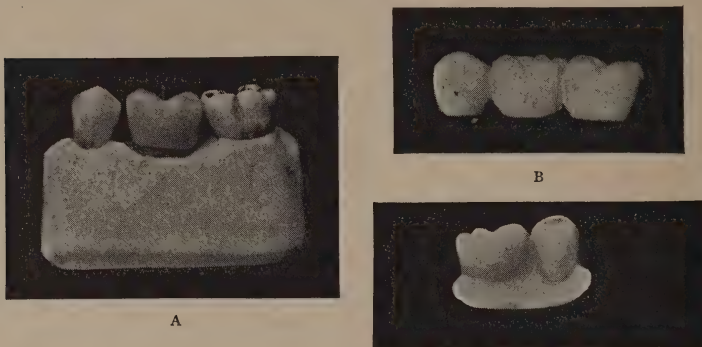
[1] To smooth and polish tooth.

absence the case for tube teeth and porcelain rods becomes stronger. With regard to the first of these: It is to be remembered that the selection of tube teeth for crowns is sufficiently large to avoid the necessity for more than an average amount of grinding; while with regard to the second, provision can be made in most practices for the work being done either entirely, or at least carried to the point where final touching up only is required at the chair-side, by mechanical assistants, pupils, or in many cases by an intelligent secretary, and in a busy practice this plan would naturally always be followed. Practical experience has offered ample proof that a good mechanic, after a little practice, can be trusted to do the whole of the work, and that assistants and pupils quickly learn to do good work, doubtless for the reason, that shaping teeth, crowns, and bridges, appeals strongly to their manipulative, as well as to their artistic dexterity. Moreover, it is a welcome change from the usual routine of prosthetic work.

To those who may still entertain doubts with regard to the simplicity of this work, and who may doubt their ability to obtain the results spoken of, the writer suggests that they devote an hour per day, for, say, a week or ten days, and note at the end of that time the marked advance which has been made, and the confidence with which they have become inspired, not only in crown-shaping but in shaping the easier forms of bridges also. Such a fractional part of time devoted to the acquisition of such an important art, will probably prove the best spent part of professional training. Fig. 160 and others afford an illustration of what can be done by pupils who have had no previous training

in grinding or shaping teeth, and it will be observed that these first efforts have resulted in bridges which would probably be more useful, and certainly more artistic than the average.

In concluding these remarks, attention is again



A B C

FIG. 160. A, Shows a tube molar crown mounted on capped roots; crown shaped from tube rod No. 25. The first effort of a young pupil who had no previous training. B, Shows a birdge formed from tube rod No. 25; second effort of a young pupil. C, Shows small saddle bridge.

directed to the fascination of the work. Those who have had experience unanimously agree that shaping up becomes a pleasure instead of a toil and, as already remarked, this doubtless arises largely from stimulation of the artistic, as well as the mechanical instincts.

CHAPTER XII

BRIDGE WORK

HAVING dealt with the use of tube teeth and porcelain rods in crown work, it is now proposed to consider their application in bridge work, but no attempt will be made to deal exhaustively with the hygienic, or physiological principles of the subject, as it will be taken for granted that the reader has sufficient knowledge to prevent his undertaking the construction of a bridge in which one or more of these principles would be violated. As the subject is such a wide one, it is further proposed to confine it mainly to a description of the methods employed in connection with the use of tube rods and tube teeth. At the same time, the reader's attention is directed to the suitability of most, if not all of the methods described for use in connection with the ordinary materials and methods commonly employed, such as the various forms of built-up or cast bridges, also those of fused porcelain, vulcanite, etc., and these remarks apply more especially to the value of the tube principle which permits of simplification and extension of most of the anchorages in use and the addition of others which have not hitherto been described.

While it is not considered necessary here to enter into the early history of fused porcelain bridge work, it may be said that the modern attempts to establish it on a satisfactory basis originated in the

efforts of Dr. Parmley Brown, and Dr. Laud about 1886. These attempts received with much enthusiasm for a time, failed to fulfil the promises to which they gave rise, and this is not surprising when one considers how inferior, with regard to strength, fused porcelain is as compared with manufactured porcelain. There are other objections such as the great time and labour involved, shrinkage, warpage, and colour difficulties. These are sufficient to relegate its use to a limited number of cases, and even in these success is only to be obtained by the expert. There is one important point in connection with fused porcelain work upon which all writers are agreed, namely, that it must not be depended upon to provide any of the strength of the piece. In consequence of this defect, it is necessary to employ an iridio-platinum framework of sufficient strength to withstand all likely strains; indeed, it must be calculated as constituting the strength of the bridge without any dependence being placed upon the strength of the porcelain. At the same time, such strength as the porcelain possesses must be conserved, and so the metal framework, or substructure, must be constructed with the object of interfering as little as possible with the continuity of the porcelain, otherwise fracture or chipping of the latter will result. Indeed, it is almost impossible to avoid this if the porcelain is at all thin, and this is another of the difficulties to be faced. The framework, then, is of the utmost importance, and the details of its construction call for much care and thought in order to avoid the many pitfalls associated with this work. Usually the framework consists of an iridio-platinum saddle, supplemented by the addi-

tion of a wire or bar of the same, to which the pins of the teeth are soldered with 25 percent platinum solder. Such a framework frequently receives additional supports. There are few cases in which it is safe to dispense with the metal saddle, and these are confined to very short bridges, not subjected to the strain of biting. In the case of a posterior bridge an iridio-platinum base or saddle is imperatively necessary. The conditions, therefore, which are essential to the successful employment of fused porcelain include those in which ample space exists to permit of sufficient bulk of material, and those are confined to a very limited class, in which absorption is in excess of normal. Even when these are met with, and room is found for the various metal parts and porcelain facings, little is left for the porcelain body. Except in those somewhat uncommon cases of extensive restoration where gum body is also employed, it is hard to see what advantage is gained by the use of fused porcelain. Much has been claimed for it on æsthetic grounds, but these claims seem to rest upon a somewhat slender foundation, as it must be apparent that what is gained in this way is due more to the facings than to the fused porcelain, which occupies a subordinate place.

Most of the objections spoken of in connection with fused porcelain may either be entirely eliminated, or at least greatly reduced by employing tube teeth or porcelain rods, particularly the latter, which afford a substantial foundation on which to build an efficient and ready means of anchorage, provision for additional strength by means of one or more horizontal bars, and other advantages which will be apparent later on.

With regard to the use of tube teeth in bridge work, their sphere of usefulness is here more restricted than in crown work, for the reason that the method of attachment sometimes necessitates the use of such an amount of gold for the purpose of giving the needed amount of basal support that either an insufficient amount of self-cleansing space is provided, or else the strength of the porcelain is unduly sacrificed. If the bite is an open one, or even moderately open, then these objections are less marked. At the same time, tube teeth are better suited for bridge work than any of the other forms of teeth or detached post crowns, and readily fulfil the conditions for which these are considered specially fitted, while they have the added advantages which were apparent in connection with their use in crown work.

As tube teeth have been sufficiently described in connection with crown work, it is proposed to deal here mainly with tube rods used horizontally, and to direct attention to the advantages obtained by their use in this way, whereby great strength is obtained without adding to the bulk of the piece.

The various forms of tube-rods have been illustrated in Chapter II, while in Chapter X have been given numerous illustrations of two or more crowns shaped up from the double-tubed rods, with the tubes in the vertical position, as in ordinary tube teeth. By the use of the shaded rods previously referred to, with the tubes in a horizontal position, either of the principal colours may be used to form the incisive or cervical portions of the tooth as best suits the case; or the rods may be shaped up in most cases in such a manner that the middle

portion where the two shades blend may be given such place as may be desired. In this manner as great a range of adaptability with regard to shade may be obtained as by any form of plain tooth. The foregoing description with regard to the variations of shade has reference to the rods when the tubes are used horizontally, but it is obvious that further variations may be obtained when they are used vertically. When the rods are used horizontally instead of vertically, almost any form of bridge may be shaped up from them, the limitations with regard to their use being governed chiefly by two factors, namely, strength and the ability of the operator in shaping the material to meet the requirements of the case. The question of strength will depend mainly upon the length of the bridge and closeness of the bite, and unless the latter is abnormally close, manufactured porcelain of good quality, even without added support, affords ample strength. By the method under consideration, however, additional strength is imparted to the piece by means of the horizontal posts or bars, which would show on cross-section as great an amount of metallic support as is found in the ordinary gold bridge with porcelain facings, and owing to the greater tensile strength of these rods compared with a like bulk of solder — upon which the ordinary gold bridge is made mostly to depend — the comparison in favour of the porcelain bridge is more marked. Moreover, these bars add nothing to the bulk of the piece, while they add to its strength, and heavier bars may be employed by the simple expedient of enlarging the tube in the tube rod by means of the diamond reamer.

The selection of the rods or blocks which will give the best results with the least expenditure of time and labour is a matter of experience. Judging by the eye alone, the tendency is to select a larger

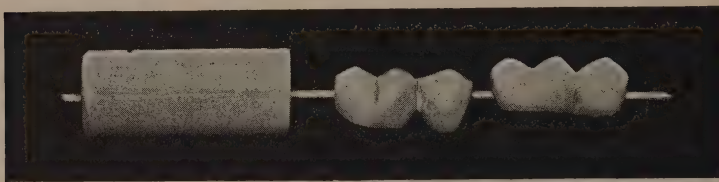


FIG. 161. A, Shows section of tube rod No. 24. B, Shows crowns wrongly shaped in their relation to the horizontal tube. C, Shows crowns correctly shaped in relation to tube and giving maximum amount of strength.

size rod or block than is necessary. In consequence it is best to measure the maximum length and breadth of teeth which will be required. With a view to obtaining sufficient porcelain to cover the cap or caps if these are employed for anchorage, the depths will also require to be taken into consideration.

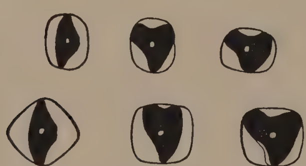


FIG. 162. Showing some variations in outline of teeth which may be formed from tube rods Nos. 24 and 25.

Until sufficient skill is acquired in judging of the most suitable size of rod or block by the eye, it is best to use a small flexible millimetre measure, and a pair of dividers. The position of the tube, or, in the case of double-tubed rods, of the tubes (Fig. 161), in connection with its position in the finished piece, is also a matter which requires careful consideration, as upon this position the question of anchorage and strength largely depends, and the position of the tubes in their relation to the end of the single and double tubed rods Nos. 24 to 30 in-

clusive is shown in Figs. 162 and 163, which also show how the shaping up of the teeth in some cases

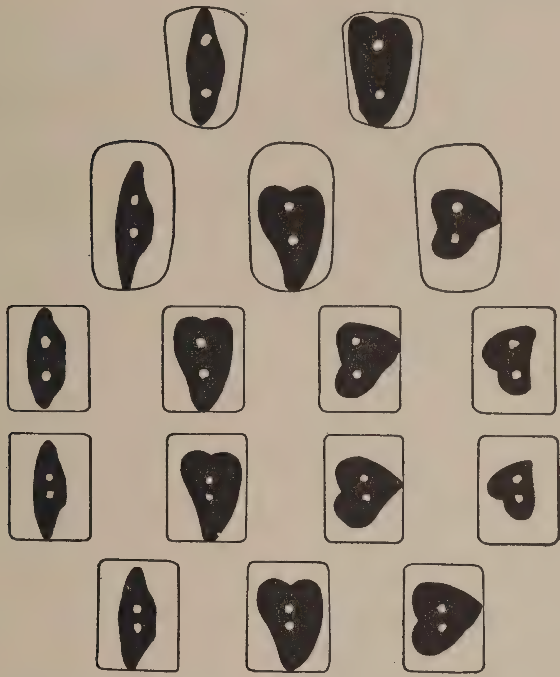


FIG. 163. Showing some outlines of teeth in their relation to the double tube which may be formed from tube rods Nos. 26 to 30.

may be carried out to the greatest advantage both with regard to the bridge and the relation or position of the anchorage bars. No disadvantage arises from the employment of a rod larger than is necessary other than that which results from the extra time and labour involved in the grinding and shaping.

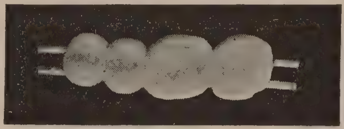


FIG. 164. Double tube bridge for shallow bite.

The rods and blocks which will be found most

generally useful are single tube rods Nos. 24 and 25, and double tube rods Nos. 26 to 29 inclusive. The single tube rods Nos. 24 and 25 will be found to provide sufficient material from which to shape up bridges in which the teeth are of moderate size or length (Fig. 162), while the double tube rods Nos. 26 to 32 inclusive, the special blocks Nos. 33 to 38, and also the special square rod No. 39, may be substituted for the single tube rods which, owing to their larger size, allow of wider application. Moreover, they provide increased anchorage and strength in the case of very shallow or close bites, particularly when used as in Fig. 164. It will be apparent, therefore, that there are very few cases which cannot be met by the use of one or other of these rods or blocks.

FIG. 165. Models from which to shape up porcelain block.

The method of shaping up a tube rod to form a porcelain bridge differs only in some minor details

from that followed in shaping up two or more teeth from a double tube rod, and is briefly as follows: — A model and bite having been obtained, a suitable

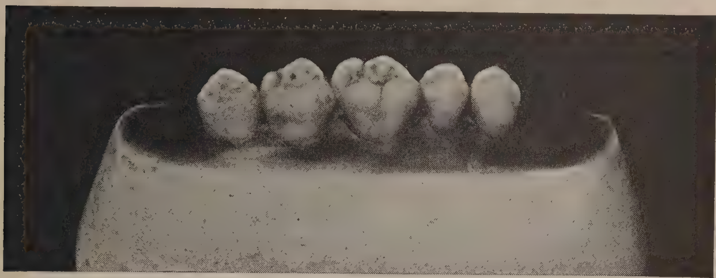


FIG. 166. Shows block with natural teeth as model for copying.

rod is selected and a section is cut off a trifle longer than is necessary to fill the space between the abutments. Having decided upon the number of teeth which will be required to fill the space, select teeth of suitable shape and size, and rough-fit them to the space; then fix them on to a small block of wax or gutta-percha, and having adjusted them, remove the block with the teeth in position, and preserve it as a model from which to shape up the porcelain block (Figs. 165 and 166). Then a little should be scraped off the plaster teeth to allow of slight fulness for finishing and polishing as already described in connection with fitting and shaping tube crowns. Next, fit the block into the space between the

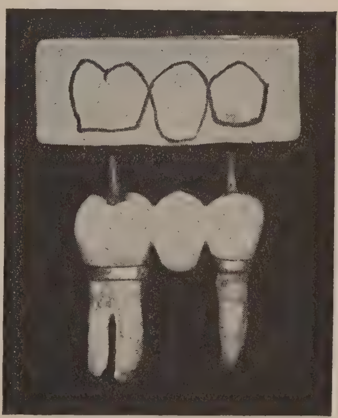


FIG. 167. Shows method of outlining teeth on block.

abutments so that it will impinge closely against them, as it invariably should do. The teeth should next be outlined in pencil on the block (Fig. 167), but when some experience has been gained this may be dispensed with, and the shaping up proceeded with (Figs. 168 and 169). When the case is similar to that shown in Fig. 170 where the cervical margins are meant to impinge upon the gum, the division

A
B
C
D

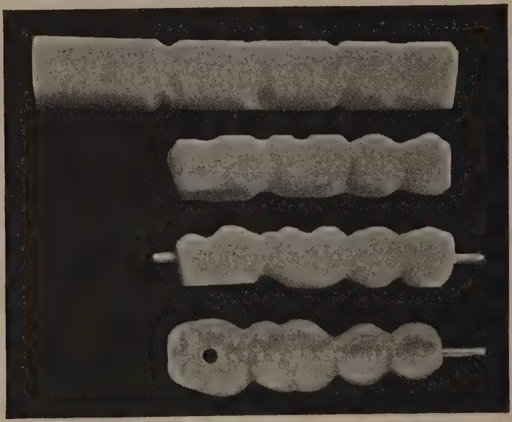


FIG. 168. Shows three stages in shaping up a bridge from rod No. 24. A, Teeth roughly outlined. Time 4 min. B, A further stage and section cut off. Time, 10 min. C, Shaping up completed. Time, 80 min. D, Coronal view with tube drilled for molar anchorage.

between the teeth should be made pronounced at these points, for which purpose a mitre-edged wheel may be used, and the division should be continued in a gradually decreasing degree until the incisive edge in the case of the front teeth is reached, otherwise spacing between the front teeth at this point will result. In order to correct such a fault, when spacing at the incisive edge is not desired, it will be necessary to grind off the labial surface so as to

reduce or obliterate the cut. The danger spoken of is less in the case of the grinding teeth, owing to the rounded shape of their buccal surfaces, and this applies more particularly in the case of bicuspids than it does in that of the molars.

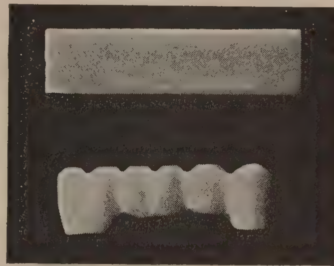


FIG. 169. Shows four-tooth bridge roughly shaped up from rod No. 26. Time, 16 mins. Wheel used 3 inch by $\frac{3}{8}$ inch. Grit 100.

In the shaping up of the labial and buccal surfaces of the teeth, the vulcarbo points and discs spoken of in Chapter X will be found indispensable, particularly the points, as their sharp edge serves to deepen the division between the teeth, while their shape permits of the desired contour being given to the tooth without the danger of interfering with the approximal surface of the adjoining teeth.

Generally speaking these points are best used in the engine hand-piece, or the flexible arm and hand-piece attached to the lathe, as thereby greater freedom of movement is obtained than when the lathe alone is used.

FIG. 170. Bridge of three upper incisors.

When such a bridge as that shown in Fig. 171 is shaped up, the procedure, as far as shaping up the necks of the teeth is concerned is different, and to the beginner will appear difficult, and the apparent difficulty consists in sharply defining the necks of the teeth without injuring the teeth on either side. This, however, can be easily and safely accomplished

by employing a No. 12 S. S. White vulcarbo point in the manner shown in the accompanying illustration (Fig. 172) wherein it will be seen that if the edge of the concave disc-shaped vulcarbo point is pressed while it is revolving against the labio-cervical margin of the porcelain, and the disc is meanwhile carried to the left in the direction of the arrow, a groove can be readily formed which will represent the segment of a smaller circle than the disc which forms it.

Fig. 171. Shows lower front tooth bridge of six teeth from tube rod No. 27.

By the use, then, of No. 12 disc in the manner suggested, it is quite easy when the point is worn or shaped down by about one-third to define sharply,

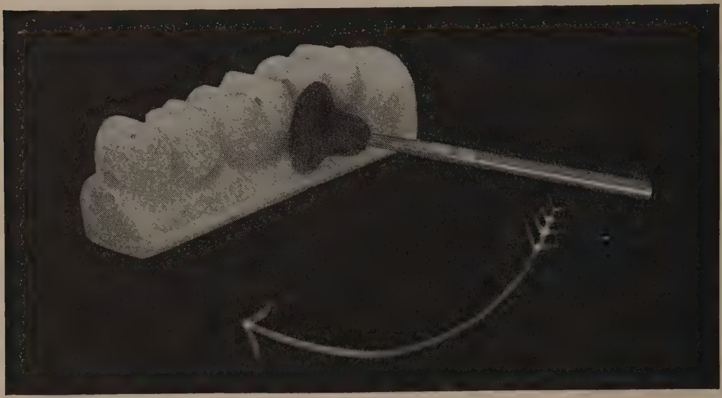


Fig. 172. Shows method of defining cervical outline.

indeed deeply undercut, a lower incisor at its cervix without danger of injury to the adjoining teeth.

Throughout the shaping-up process, care must

be taken that the tube or tubes are maintained in the position which will afford the best anchorage for the bars, while at the same time they are not permitted to obtrude on the labial or buccal surfaces, except, of course, in cases where this cannot be avoided. For instance, in forming a bridge in one piece, involving the four incisors, from rod 26 or 27, and particularly if the arch is a V-shaped one, the tubes may become exposed on the disto-labial surface of the laterals (Fig. 173). In order to avoid this as much as possible and obtain the maximum amount of porcelain labially, that is, in front of the tube or tubes, care should be taken during the shaping up process to leave the labial surfaces of the central incisors to be dealt with near the end of the work. Generally speaking, therefore, it is better to leave the glaze at this point, or at a point on the surface of what will be the most prominent tooth or teeth in the finished case, as a guide, in order that too much may not be inadvertently removed before the shaping up is well on the way; otherwise it is often difficult to estimate the relation of the tube to the labial surface of the teeth if the glaze has been removed at an early stage. In this way the bar or bars need show very little, if at all. Should the bars be exposed, however, they may be smoothed off to look like two small fillings; or inlays may be formed on the end of the bars.

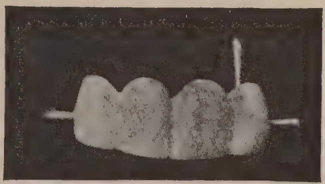


Fig. 173. Bridge of four upper incisors for contracted arch.

Curved Blocks. It will be seen later that the curved blocks Nos. 33 to 38 may be used in most cases in

place of the rods spoken of, and that they prevent the tubes becoming exposed on the labial or buccal surfaces of the teeth. Moreover it will be found that the curved blocks referred to need not have their tubes centrally situated in relation to the post which enters the root canals, but that an additional post may be soldered on any part of the cap or caps. In consequence the range of adaptability of these blocks is more extensive than it would appear.

Anchorage in Bridge Work

While all the forms of anchorage suited to bridge work may be used in connection with tube rods, there are others to which they are peculiarly suited. Before proceeding to offer evidence in support of this statement, the readers' attention is directed to the facilities which tube rods offer for the purpose of providing attachment for the forms of anchorage with which he is already familiar. These need not be enumerated here, as many of them will be shown in connection with the examples of various forms of bridges which are to follow. It is sufficient merely to point out that anchorage may be obtained through any convenient part of the body or span of the bridge, also from either end, and that this can be done not only without weakening the bridge or adding to its bulk, but actually adding strength. The porcelain rods are strong enough to sustain any amount of strain which the anchorage teeth would be likely to bear, while additional strength can be readily obtained by enlarging the tube or tubes by means of a diamond reamer in order to substitute heavier or stouter bars; and if need be still greater strength can be imparted to the bridge by further enlarging

the end of the horizontal tubes and forming a recess into which an inlay can be formed on the horizontal bar or bars (Figs. 174, 175 and 176). Such an arrangement provides for the attachment of any anchorage device desired. In short, by the simple means referred to, the abutment piece or pieces which form an integral part of the body of the bridge in all ordinary cases, can be treated either as a fixed or else as a removable attachment. Thus, most of the bridges in which the tube system is employed are really provided with a double system of removable attachment, because the horizontal bars, ordinarily joined together with an inlay, telescopic crown, or other similar device, are readily detached from the body of the bridge, while the bridge itself can be readily detached or removed from the anchorage or abutment piece fixed on to the teeth or roots.

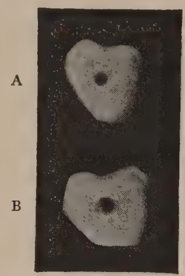


FIG. 174. A, Tube normal size. B, Tube enlarged.

Vertical tube anchorage can frequently be employed in combination with horizontal tubes and posts, or alone, and examples of the latter are to be seen in Figs. 182 and 205, which show double tube crowns formed from tube rods or two or more crowns from tube blocks.

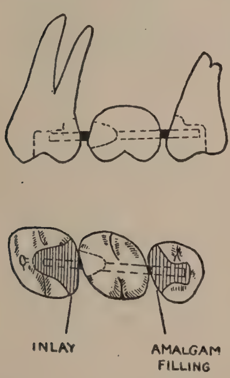


FIG. 175. A simple form of bridge.

Where an additional tube or tubes have to be provided, this may be done in two ways: — first, by drilling a hole through the porcelain rod; second,

by forming a groove in one or both ends of the section of porcelain rod for the accommodation of a metal tube to which the horizontal bar or bars are soldered, or these may be joined together by an inlay (Fig. 177). With regard to the first of these methods, drilling holes in porcelain is usually looked upon as a somewhat tedious operation, but much depends upon the

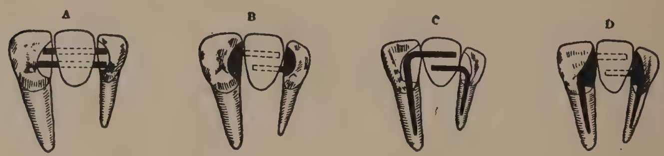


FIG. 176. Various forms of attachment as described in text.

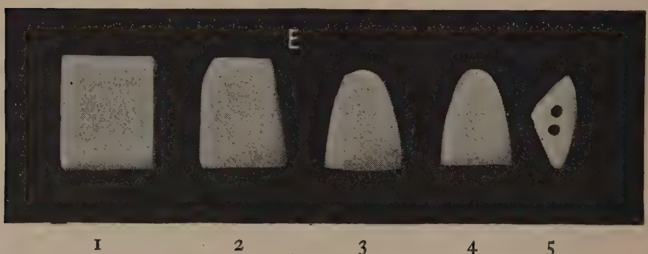


FIG. 176. Stages in shaping up a central incisor from double tube rod. 1, Section cut from block; time, 3 min. 2, Rough shaping up; time, 6 min. 3, A further stage; time, 3 min. 4, Shaping up completed; time, 18 min. 5, Side view. (To this would have to be added 10 min. for smoothing and polishing. Total time, say, 30 min.)

drill employed, and most of all upon its cutting qualities, because it is not every diamond drill sold for the purpose that will cut well; indeed, some are quite worthless, and so it is well at once to discard these. Diamond drills may be had in a size suitable for drilling a similar tube to that in the non-platinum tube teeth and rods, and in selecting a drill for the purpose, care should be observed that the steel setting does not project beyond the diamond cutter.

If it does so, it will prevent the drill from cutting deep enough, at least until the steel shoulder has been worn down by friction with the side of the tube, but this may result in dislodging the stone. Given, however, a suitable drill the work may be accomplished much more easily and quickly than one would suppose.

A

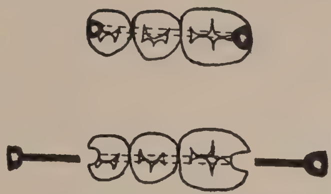


FIG. 177. A, Shows coronal view of section of porcelain rod with groove formed in ends for the reception of tubed inlays.

It is essential for the proper carrying out of this process that the drilling be done under water, and very little pressure should be applied. A rubber cup, similar to that shown in Fig. 120, Chapter X or one of larger size which will hold a porcelain rod, should be used, and the drilling carried out in the manner described in connection with "Grinding under Water"; or a shallow vessel filled with water should be employed, in the bottom of which a piece of rubber is placed, upon which the tooth is held while the drilling is being carried out; or in like manner it may be stuck in a piece of lac, or a modelling compound.

B

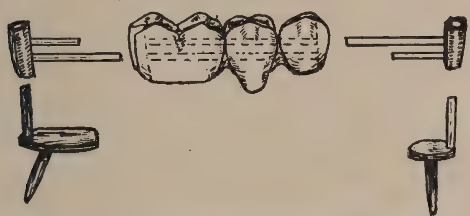


FIG. 177. B, Buccal view showing tubed inlays joined to horizontal bars.

C

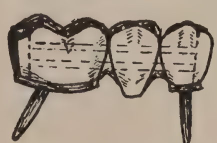


FIG. 177. C, Shows completed bridge.

With regard to the time necessary to drill a tube in a porcelain rod, a series of experiments has proved that such a tube can be drilled through rod No. 25

to the horizontal tube in about five minutes if the drill is a really good one. Under ordinary circumstances, then, a sufficient time to allow for this would be, say, from ten to fifteen minutes.[1]

A tube may also be drilled in the same way by means of a Butler's point, medium or coarse grit, mounted on a porte-polisher and thinned down to size of $13\frac{1}{2}$ U. S. Gauge wire. It is astonishing how fast such a point will cut. If a slight rotary motion is given to it (see Chap. X, page 171) this will necessarily mean making the tube somewhat larger than the carborundum point. If the point has not this additional rotary movement given to it, the rate of cutting will be much slower. A considerable amount of pressure may be used in drilling, and it is surprising how much pressure can be used on a thin carborundum point without breaking it.

Another, but very slow method is to use a copper point with a square end, mounted in the porte-polisher, and used in the same way along with carborundum powder, grit 200, and with sugar solution.

The second method of obtaining anchorage by means of vertical tubes does away with the necessity of drilling a special tube in a porcelain rod, and is applicable to all except a few cases involving the incisors, where the additional groove would, under certain circumstances, result in unduly weakening the lingual wall of porcelain tooth at the junction of the horizontal tube and the vertical groove, particularly when a double tube rod is used. But in connection with the grinding teeth, the occasional disadvantage referred to is not apparent. The application of the principle is seen in Fig. 177, also

[1] Most dental depots will undertake to drill these for a small sum.

in connection with shaping and fitting porcelain plates in Chapter XV, and it may also be used in connection either with single or double tube rods in bridge work where it is to be preferred to the sometimes troublesome method of forming an additional tube by means of a diamond drill as well as because of its greater adaptability. In connection with a porcelain bridge the procedure is as follows:—section of porcelain rod, usually 26, 27, 28, 29, or 39, is cut off, sufficient to fill the space between the abutments. It is then roughly fitted to the caps of the anchorage teeth, a vertical slot or groove of suitable size is next made at each end of the block, and these grooves should be exactly parallel to one another, and at right angles to the horizontal tubes in the porcelain rod, which they will either intersect or pass between. This will depend upon whether the rod is used with its broad or narrow surface towards the gum. The grooves in the porcelain block should be accurately cut to take a section of tubing the walls of which are not more than 36 U. S. Gauge, and the tube should take a solid post about $13\frac{1}{2}$ U. S. Gauge. The horizontal bars should be soldered to the vertical tubes (Fig. 178) and in order to make certain that the posts and tubes are exactly at right angles to one another the tubes should be left sufficiently long to begin with, and cut off to the required length after soldering. Not only does this plan provide a ready and simple means whereby the relation of the vertical tubes to the horizontal bars can be accurately gauged but it also provides a simple and accurate means of obtaining parallelism between posts or other appliances used as anchorages at the opposite ends of a bridge, and thus does away with

the necessity of employing one or other of the instruments devised for this purpose. Generally it is advisable to combine the tubes and posts in an inlay. The groove need only be sufficiently deep to permit of the tube being flush with the porcelain wall at either end of the section of porcelain rod, and it should not be made deeper than is necessary in order to avoid unduly weakening the porcelain.

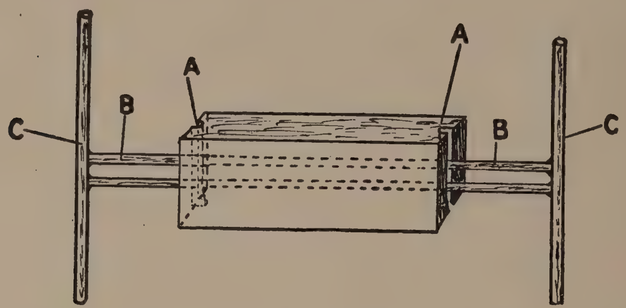


Fig. 178. Shows tube rod with horizontal bars and vertical tubes. A, Shows grooves in porcelain rod. B, Shows horizontal bars. C, Shows vertical tubes.

By the foregoing simple methods, the section of porcelain rod from which a bridge is to be shaped up is transformed into a block with vertical tubes, and can be used in the same way as the tube blocks Nos. 33, 34, and 35.

The foregoing description of a means whereby a section of tube rod may be easily converted into an elongated section of a tube rod with vertical tubes in addition to horizontal ones, brings us to the consideration of the question of parallelism of abutments.

Parallelism of Abutments not Necessary

When one considers the extremely important part which anchorage plays in connection with bridge work, it is not surprising to find that this subject has had more attention and thought given to it than any other point. In consequence an immense variety of methods have been suggested and many appliances evolved mainly with a view to overcoming the difficulties of attachment which are mostly encountered in connection with fixed bridge work, although the problem is one which also taxes ingenuity in connection with removable bridge cases. It is a cardinal rule laid down by most writers that it is necessary in connection with fixed bridge work that not only must the remaining walls of the natural teeth which are to form the abutments be made parallel, or less than parallel in the same way as for individual crowns, but that the axial walls of the abutments must be reduced until they present parallel lines, and that much less than mere parallelism is required if "telescope" or similar crowns are employed otherwise the subsequent adjustment of the bridge will be impossible, or else the crowns will not even approach a close fit at the necks of the teeth. If the anchorage consists of an all-gold or similar crown at one end, and a dowel crown at the other, and the root of the dowel crown is not parallel with that of the former, it will be necessary to reduce the projecting walls of the root supporting the gold crown until a near enough approach to parallelism is obtained, sufficient to enable the bridge to be got to place. Frequently it is also necessary to enlarge the orifice of the canal of the anterior abutment to permit the

post to enter it. When two or more post or dowel crowns are employed, it is also necessary to have the axis of the root canals and the walls of the roots which are covered by the collars, parallel to one another, otherwise they cannot be set when rigidly united.

It is obvious that these arguments are sound, and must hold good in the case of the ordinary forms of fixed bridges, as in them the attachments or abutment pieces form an integral part of the bridge and are joined to it in one continuous piece; whereas in bridges formed from tube rods, or where bridges are formed on the tube rod principle, these difficulties are readily overcome, as tubes permit of the use of certain forms of anchorage devices not hitherto described. This will be apparent when it is called to mind that parallel vertical tubes and posts can be employed without in any way interfering with the post or posts in the canals of the abutment teeth. The horizontal tubes provide a ready means either for a removable or permanent attachment of abutment pieces or anchorage devices. Possibly the reader will grasp the idea more readily by referring to Fig. 189.

The following, then, are only some of the many forms of anchorage which need be described, but they will doubtless be found to afford a sufficient choice to meet most requirements, or to suggest the means whereby such modification may be carried out.

Anchorage by split posts.[1] The value of the split

[1] In connection with most of the removable bridges illustrated, solid posts could be substituted for split ones if a fixed instead of a removable bridge was desired.

post as a means of securing attachment of crowns to roots, and also in connection with other prosthetic appliances, was very early recognized and largely taken advantage of. In more recent times it was extensively employed in Europe, where it was prominently brought before the profession about 1875, by Mr F. H. Balkwell[1] of Plymouth, and later by Dr. H. K. Leech,[2] of Philadelphia. Afterwards improvements were added by Dr. F. Peeso of Philadelphia with whose name it has become intimately associated, and to whom the profession owe several excellent forms of bridge attachments. This form of anchorage has not hitherto been as popular as its excellence as a form of attachment warrants. The method usually adopted has been that suggested by Dr. Peeso, and consists of a metal tube soldered to the cap for a root in a manner similar to the solid post of a porcelain-faced crown, the cap and tube being permanently fixed in the root, while the split post which enters the tube is permanently fixed to the bridge.

The objections to this form of anchorage are based mainly on the extensive enlargements of the canal for accommodating the tube whereby the root is unduly weakened (Fig. 179). In consequence, the use of this form of attachment is confined almost exclusively to the canines. A much better plan, however, is to reverse the application of the component parts of the attachment, and form the tube through the body of the bridge while the split post is attached to the cap in the same manner as with a

[1] Mr F. H. Balkwell, L.D. S., Paper in "British Journal of Dental Science," January, 1878.
[2] Dr. H. K. Leech, D.D.S., "Dental Cosmos," Vol. XXI, p. 232.

tube crown. Some of the advantages derived from reversal of the parts played by post and tube are: — Simplicity of construction; conservation of tooth substance due to lack of necessity for undue enlargement of the root canal and suitability for use in any size of root; increased strength of attachment, and easiness of repair. There is no necessity for enlarging the canal more than for a single crown. Any size of post may be used, as that part which enters the canal can be reduced while the split post projecting from the cap may be left as stout as desired, and as the strength of a split post is less than that of a solid post of equal diameter, the advantage of employing a stouter post than is possible under the older method will be apparent. Moreover, such a form of split post and tube may be used in connection with the bicuspid and molars or any other teeth, and its use is not confined to the canine or other large single roots. With regard to easiness of repair, it will be obvious that by the method suggested, replacement of a broken post would only involve removal of the cap and post from the root, and soldering a new split post to the cap. Provision would ordinarily be provided for easy removal of the cap by anticipating such a possibility, and fixing the caps with guttapercha, or guttapercha and cement, while by the older method the application of a new post is not only more difficult, but involves the risks incident to resoldering with its attendant danger of cracked facings.

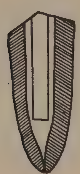


Fig. 179. Shows root unduly weakened.

When a split post is used in such a manner that it is not continuous with the post entering the root,

as it generally must be in the case of a molar, then it is well to employ a stouter cap than usual, as a greater strain is imposed upon the post when the bridge is not cemented to the anchorages, and in consequence a greater lateral strain is imposed upon the caps. These latter should therefore, be made extra stout, say size 28, and additional strength may be obtained by allowing the split post to project through the cap (Fig. 180) into the pulp chamber, and further strength gained by uniting it to the post entering the canal.

FIG. 180. Post projecting through cap in order to obtain additional strength.

The modifications therefore, which are suggested in connection with tubes and split posts makes this form of attachment capable of being employed successfully in connection with most of the bridges illustrated.

Anchorage by means of inlays. The important part which inlays play in connection with the uses of tube rods, will be seen in the illustrations of various bridges and other prosthetic pieces shown. It is unnecessary to describe inlay-making in detail, as the process is doubtless well-known to the reader, and so the subject will merely receive passing notice.

The casting process most often gives the best results, but in certain simple cases equally satisfactory results may be got by burnishing a pure gold or thin platinum matrix and flowing it up with gold of suitable carat.

The ends of posts or bars on to which inlays are cast, should be roughened in order to obtain a secure hold or attachment between them and the inlay, and it is advisable to flow a very small piece of solder

on to the end of each post or bar on which an inlay is to be cast, in order that union between the pieces may be made more certain. Indeed, it is safest when the inlay is a small one, or when a doubt may exist with regard to the strength of the union of inlay and bar or post, to solder the parts together. Where, for instance, bands or clasps are to be united to inlays carrying posts or horizontal bars, it is best to cast the inlay on the horizontal bars, and join the combined inlay and bars to the band by means of solder.

Inlays combined with tubes are extensively used in this work. The method of doing so is extremely simple, the only precaution to be observed is to note that the tube is filled in the manner described on page 98, Chapter VII, in order to prevent it from being filled up with gold or solder, or having its interior damaged in any way during the casting process. It is also advisable, of course, to solder posts or bars to tubes before combining them in an inlay, as greater strength is thereby obtained.

In the case of a single tube rod, the cavity or recess for the inlay should be shaped with a view to prevent rotation. This is less necessary in the case of double tube rods, though it has the advantage of distributing the stress over a larger area, and so greater strength and support is given to the porcelain.

The combination of inlays with horizontal bars, permits of a wide range of application, and allows of two or more pieces being united in the most rigid manner. The principle of tube bar and inlay will be found invaluable in every class of prosthetic work, and as already mentioned in this chapter, can be advantageously applied to bridges, plates, etc., in

all materials, while all of the ordinary forms of attachment, as well as the many forms of special ones can be employed.

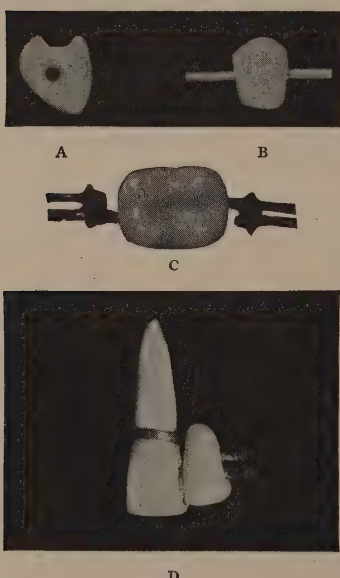
Some of the combined inlay and bar anchorages described are shown in Figs. 128, 129, 130 and 132D.

CHAPTER XIII

BRIDGE WORK (*continued*)

FIG. 181A, B, C, and D, show three of the simplest types of bridges which can be formed more quickly from tube rods than by any of the other methods of bridge work commonly employed.

A. Shows the side view of a tooth formed from rod No. 24 with the tube horizontal and recessed at one end for an inlay for the purpose of receiving an inlay attached to the bar to prevent rotation.

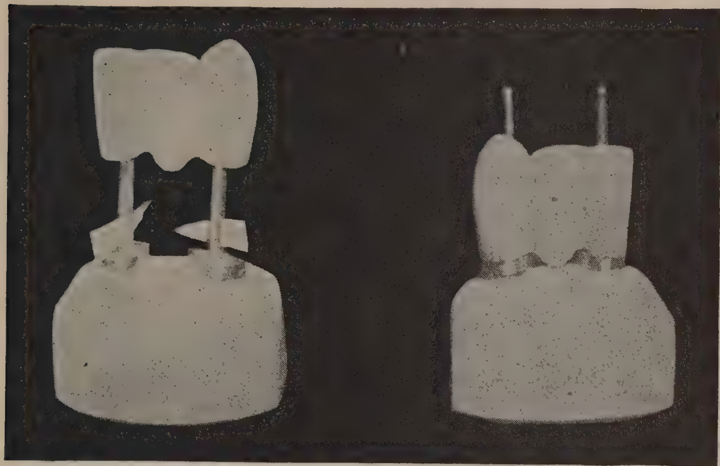


B. Shows buccal view of same tooth with bar in position. Such a form of bridge is often useful for temporary purposes or may be made permanent.

C. Shows coronal view of lower molar formed from double tube rod No. 26, 27 or 28, to fill extra large space. Bars partially withdrawn showing inlays which are sunk in the porcelain crown.

D. Shows left upper central incisor with lateral extension formed from double tube rod No. 26;

root capped and banded. Note that projecting bars from lateral provide additional anchorage.

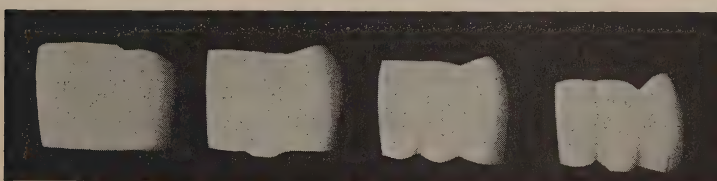


B A

Fig. 182

A. Shows lower removable bridge of three teeth formed from rod No. 32, in which vertical split posts are employed for anchorage.

B. Shows bridge partially removed. Note pieces of metal inserted to define split in posts.



C

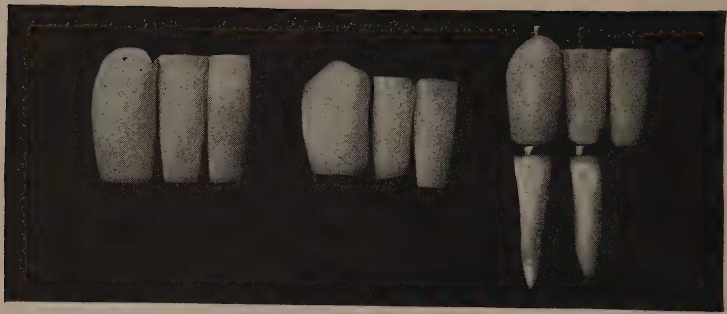
C. Shaping up three-tooth bridge.

(1) Rough shaping up — 6 mins.

(2) Fitting to caps and shaping up — 35 mins.

(3) Shaping nearly completed — 50 mins.

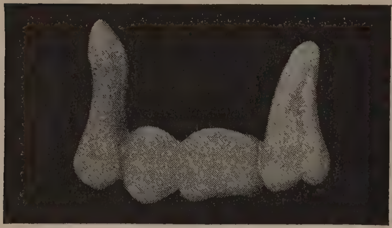
(4) Bridge completed — say, 80 mins.



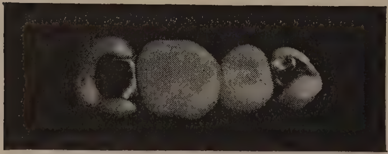
D

D. Shows three stages in forming a right lower extension bridge from tube rod No. 28. Anchorage similar to previous case.

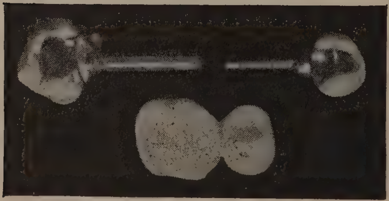
Fig. 183



A



B



C

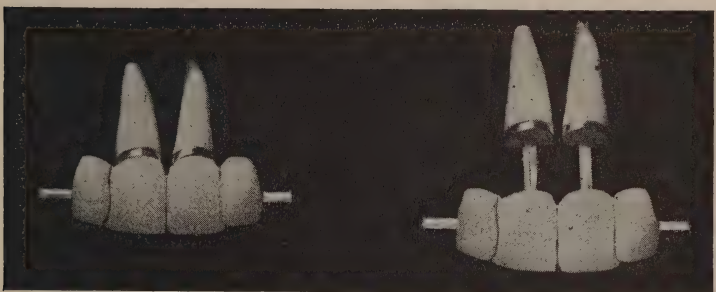
A. Shows a bridge to supply the first molar and second bicuspid of the left side of the upper jaw. The anchorage teeth comprise the second molar and first bicuspid, both of which are devitalised, and the canals filled in the usual way.

B. Shows a large cavity in the crown and anterior approximal surface of the molar, and a similar cavity in the crown and posterior surface of the first bicuspid, gold inlays being cast to fit them.

C. Shows a horizontal bar attached to the bicuspid inlay, and to the molar inlay a tube bar, into which the solid post passes as far as the molar inlay. Both inlays are extended into counter-sunk cavities in the porcelain for the purpose of preventing rotation.

Fig. 184

A. Shows an upper bridge of four incisors shaped up from rod No. 25. The anchorage is by caps and split posts on the centrals, thus constituting a removable bridge, or solid posts may be employed making it a fixed bridge. Additional support or anchorage may be obtained by utilizing the horizontal tube for the accommodation of extension bars to fit into inlays in the lingual surface of the canines.



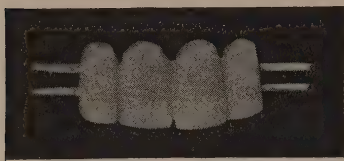
A B

B. Shows primary anchorage. Total time taken for shaping up, smoothing, and polishing—2 hours.

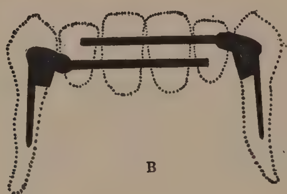
Fig. 185

A. Shows an upper front tooth bridge consisting of the four incisors shaped up from rod No. 28. A simple form of anchorage suitable for a case of this kind is shown at B, where it will be seen that a

horizontal bar is attached to each of the inlays, and that the inlays may be further extended into recesses cut into the ends of the porcelain bridge.



A

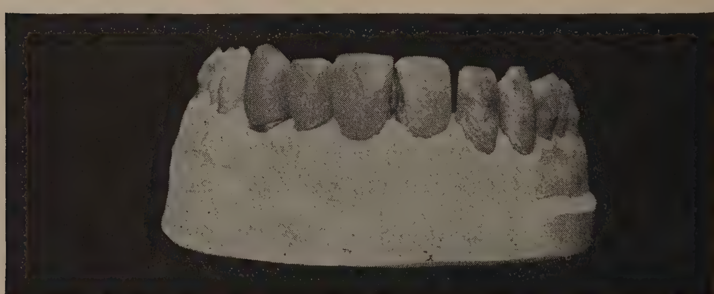


B

While such an arrangement of sunk inlays in the porcelain is not necessary, it has the advantage of providing for a greater amount of freedom with regard to the relation of the post in the canals to the horizontal ones carrying the bridge, and such an amount of latitude is often an advantage, while in the case of a single tubed rod it is doubtless more often advantageous, as it minimises the amount of strain put upon the horizontal bar.

Fig. 186

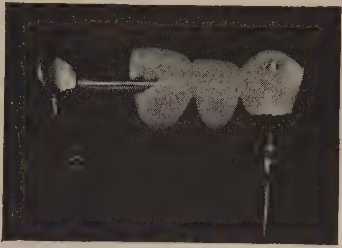
A. Shows a small bridge supplying the left upper central, lateral, and canine, and is shaped up from



A

the single tube rod No. 25. The canine anchorage is by means of a post attached to a capped and

banded root, a hole having been drilled through the porcelain rod for this purpose, and the porcelain tube is lined with a metal one. A gold inlay is formed on the end of the horizontal bar, and this fits into a gold inlay cemented into the anterior approximal and lingual surface of the right upper central.

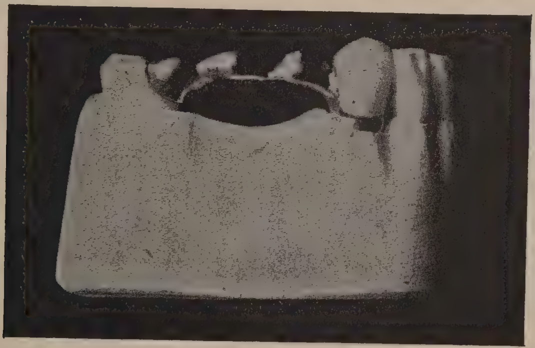


B

B. Shows lingual view with post and bar partially withdrawn showing construction.

Fig. 187

Shows a small gold bridge with large self-cleansing space, for the right lower jaw, consisting of two bicuspids and a crown. The posterior anchorage is obtained by means of a large gold inlay anchored



into the pulp chamber, and anterior root of the first molar, and the anterior anchorage by capping and banding the canine root with post attached in the usual way for the purpose of carrying a tube crown. The union of the gold cusps to the canine

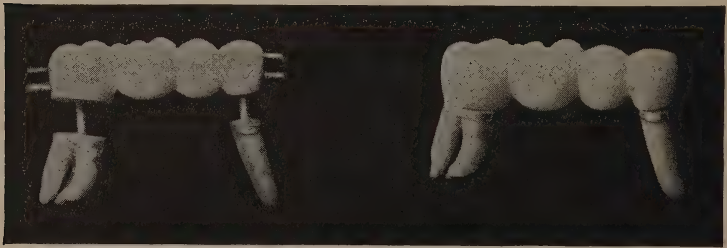
cap is carried out in the manner shown in the illustration, without interfering materially with the strength of the tube tooth.

Fig. 188

A bridge of three teeth for the left lower jaw shaped from rod No. 26. The posterior anchorage consists of an all-gold crown to which a gold inlay carrying the horizontal bars which pass through the bridge is soldered. The anterior anchorage is by means of a post passing through a tube drilled through the crown of the first bicuspid.

Fig. 189

Illustrates what has been said in "Parallelism of Abutments not necessary," and shows a method of



A B

dealing with converging or diverging roots. The illustration shows a lower molar tilted forward, and a bicuspid also tilted, so that they converge. In dealing with such a case, the molar and bicuspid roots may be shaped up without regard being paid to

their direction, and they may be capped and banded in the usual manner. The post attached to the bicuspid cap should be adjusted so that the part which projects above the cap, and which is to carry the anterior end of the bridge, is vertical to the alveolar ridge. An impression and bite should then be taken of the caps in position on the roots. The impression will doubtless come away, leaving the caps, and these should be replaced in the impression before it is cast. A suitable porcelain rod having been chosen, a hole should be drilled through it corresponding with the bicuspid post. The shaping up of the porcelain rod should then be proceeded with, the bicuspid post acting as a guide. After it has been rough-fitted and shaped up, a second hole parallel to the first should be drilled for the molar post. This may be made to intersect the existing horizontal tube, or just to one side of it, in the case of a single-tubed rod. In the case of a double-tubed rod, it may be drilled in like manner, or between the tubes when they are horizontal. The post for the molar should now be soldered in position, the tube which has been drilled in the porcelain section acting as a guide, after which the shaping up, fitting and polishing may be completed, when the piece is ready for setting.

In this manner, then, the difficulty associated with converging roots is easily and satisfactorily overcome. The horizontal bars can be cemented into the tube before the piece is permanently fixed on its anchorage. Instead of drilling special tubes through the porcelain for the bicuspid and molar posts, tubed inlays may be used, as shown in Fig. 208.

Fig. 190

Flexible Anchorage

This is another method of dealing with diverging or converging roots. Such a case as that shown would ordinarily necessitate the sacrifice of a greater amount of tooth substance than appears desirable, and as an all-gold crown may be the most suitable form of anchorage for the posterior end of a bridge, the following method of anchorage will be found to meet the requirements of a large number of cases. The figure illustrates a case of a lower right bridge of four teeth, the posterior anchorage being formed by an all-gold or shell crown in the usual way, but strengthened or reinforced on its anterior approximal surface in order to afford better support to the anchorage bars. Holes are drilled through the reinforced surface of the crown to permit the bars to pass through sufficiently far to enable their

A

B

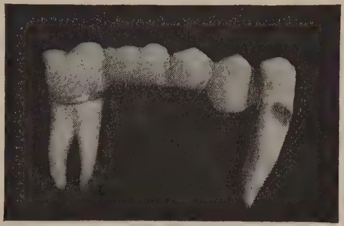
ends to be held fast by the cementing medium attaching the crown to the root, sufficient flexibility being thereby obtained to overcome excessive divergence of the abutments while the bridge is being cemented to place. The end of the bars may be roughened in order to secure a better hold for the cement. They may also be extended to the far

side of the molar crown, to assist retention, but in the writer's experience this strain antero-posteriorly is nearly always slight, and so he cannot endorse the statement of some writers who take an opposite view. The illustrations also show the anterior anchorage to the first bicuspid to be formed by means of a cap and post, a vertical tube being drilled through the bicuspid for the purpose. The horizontal posts are also shown projecting, and if need be could be utilised for additional anchorage into the canine.

Instead of drilling a tube through the porcelain rod, the alternative method of a tubed inlay may be employed.

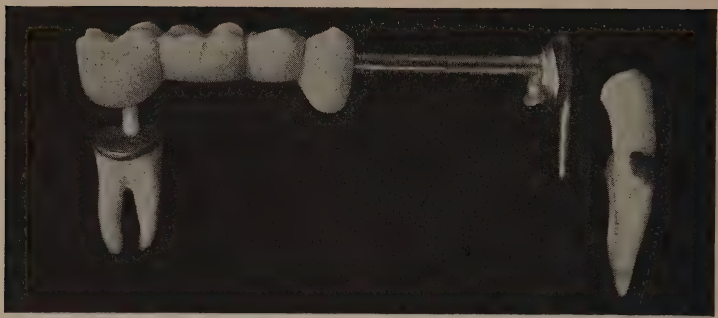
Fig. 191

A. Shows a bridge for the lower right side, consisting of two molars and two bicuspids, in which anchorage is obtained by means of an unbanded cap with post on to the second molar, and a large inlay and post into the canine. Here it will be observed that provision has been made for a large self-cleansing space by cutting away the cervical portion of the second bicuspid and first molar.



A

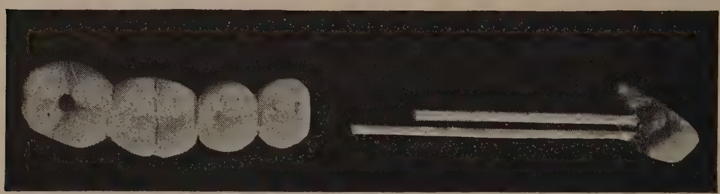
An alternative method of dealing with a case of this kind would be to form a recess or groove in the distal surface of the porcelain bridge for the accommodation of a combined inlay and vertical tube joined to the horizontal bars passing through the body of the bridge, and with the addition of split instead of solid posts for the molar and canine, and



B

with a tube inlay in the latter, thus making it into a removable bridge.

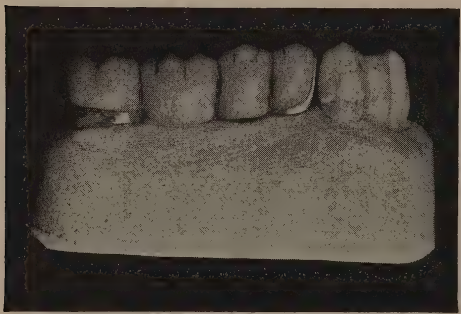
B and C. Show details of construction.



C

Fig. 192

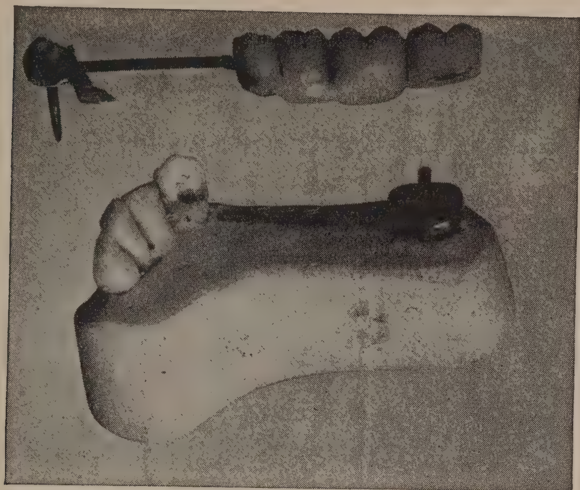
Shows a bridge for the lower right side consisting of the bicuspids and first and second molars, and is shaped up from rod No. 24. The anchorage is by means of a post soldered to the capped root of the second molar, and the anterior anchorage by means of a large gold in-



A

lay formed on the lingual surface of the canine, to which a post is attached which enters the root.

The inlay also carries a horizontal bar, which extends to the post on the molar cap, and additional



B

strength for the porcelain is obtained by prolonging the gold inlay underneath the first bicuspid on the bridge.

Fig. 193

Concealed Anchorage

A. Is that of a bridge for the left side of the lower jaw, and consists of a second bicuspid, and first and second molar, shaped up from rod No. 24. The point of special importance in connection with this case is the "Concealed" anchorage, which is carried out in the following manner. Split posts — about size 11 — are attached to the caps of the molar and

A

bicuspid, and these enter tubes which have been drilled by means of a thin Butler's point through the base of the second molar and first bicuspid, but which do not project through their crowns, and these porcelain tubes are lined with gold ones in order to afford additional strength. By this means nothing but porcelain is shown on the crown surface of the tooth, an æsthetic advantage which some practitioners will probably appreciate, but it is to be observed that the claims advanced in favour of tubes passing completely through porcelain teeth or crowns as mentioned in Chapter IV, page 43, are in no way departed from, because in a case similar to that shown in the illustration, the porcelain tube does not limit the range of adaptability, as it is drilled out after the fitting of the porcelain to the caps has been nearly completed.

B

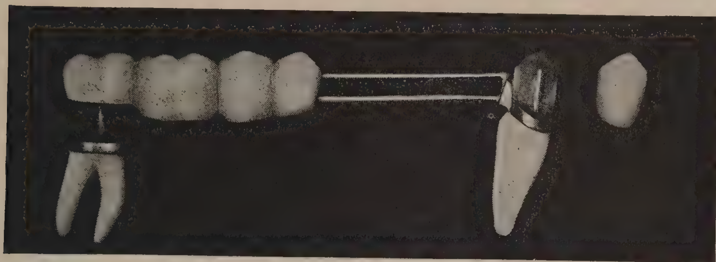
B. Shows base view.

Fig. 194

A B

A. Shows a right lower bridge of five teeth —

canine, two bicuspids, and two molars — shaped up from tube rod No. 27. The molar anchorage is by means of a post size 12 U. S. G., soldered to the



C

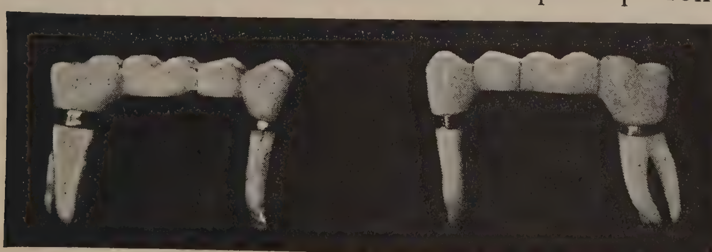
capped and banded second molar roots, and for the purpose of receiving the post, a vertical tube has been drilled through the porcelain rod, and lined with a metal tube cemented into it. The anterior anchorage is by means of a Richmond crown with a removable facing.

B. Shows lingual view.

C. Shows method of construction.

Fig. 195

A. Shows a right upper bridge of four teeth — two bicuspids and two molars — shaped up from



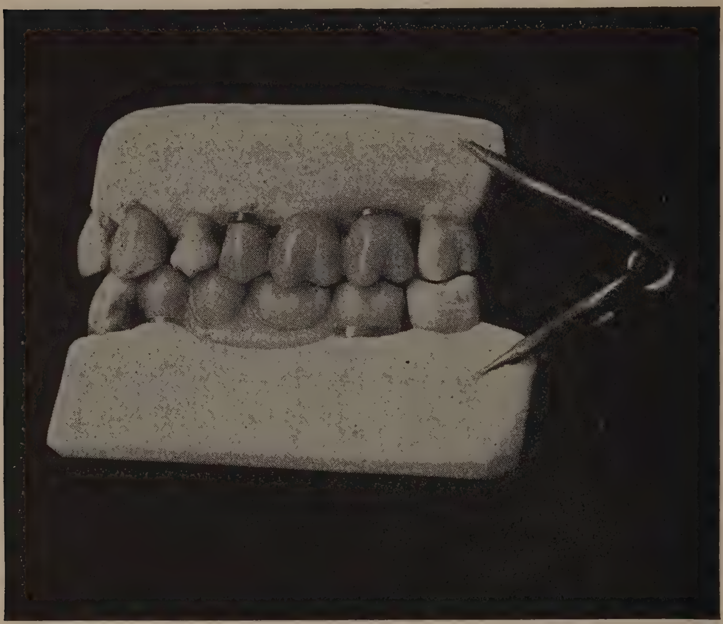
A B

the single tube rod No. 25, with a large self-cleansing space underneath the second bicuspid and first molar. Anchorage is by means of solid posts, or

split posts may be used instead of solid ones. The horizontal bar extends from the post for the first bicuspid crown to that of the molar, and in order to obtain additional strength the horizontal tube was enlarged to take a bar size 12 U. S. G.

B. Shows lingual view.

Fig. 196

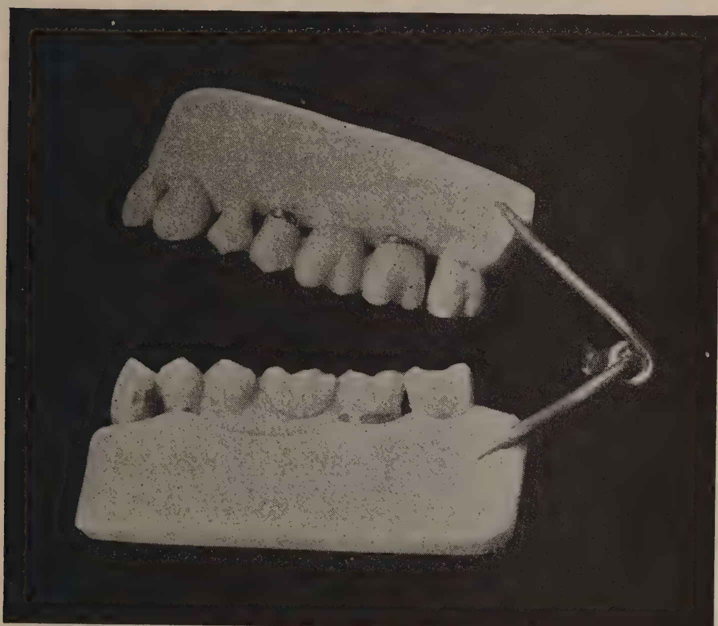


A

Shows an upper and lower bridge mounted on a bite frame and showing the articulation. The details of the construction of these bridges is as follows: —

The upper bridge, consisting of the first and second molars and second bicuspid, is shaped up from the double tube rod No. 26, although No. 25 single tube rod would have suited equally well. Anchorage for

both ends is by means of the usual cap and band with post in canal. Both caps have vertical posts soldered to them to carry the bridge. Instead of drilling tubes through the body of the bridge, vertical grooves with tubed inlays are employed in the manner shown in Fig. 208. The bridge may be made removable by substituting split posts for solid ones.



B

The lower bridge, consisting of the 1st and 2nd bicuspids and also the 1st and 2nd molars, is also formed from tube rod No. 26. Tubes for anchorage posts on the first bicuspid and second molar have been drilled through the body of the porcelain, and these are lined with metal tubes. The roots are capped and banded, and have posts in the root canals similar to those in the upper.

Fig. 197

Shows upper right bridge of four teeth, two bicuspids and two molars. The bicuspids and first molar are shaped up from the single-tube rod No. 25, while the second molar — an all-gold crown — has a horizontal bar and inlay soldered to its anterior approximal surface, extending as far as the post soldered to the bicuspid cap. The molar thus forms the posterior anchorage for the bridge, while the anterior end is anchored to the first bicuspid by means

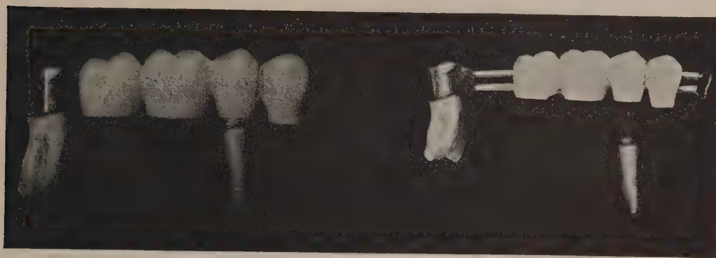
A B

of a cap and band with the usual post attached for which a tube has been drilled through the porcelain crown. In order to avoid the difficulties sometimes associated with drilling a special tube in the porcelain rod, the method shown in Fig. 177 may be adopted.

Fig. 198

Shows a bridge of five teeth for the upper left side, and here the posterior anchorage is formed by an all-gold crown, to which the countersunk inlay which joins the bars is soldered. The anterior anchorages consist of the usual cap and post for second bicuspid, through which a tube has been drilled for the post. The other anchorage is provided for by a counter-

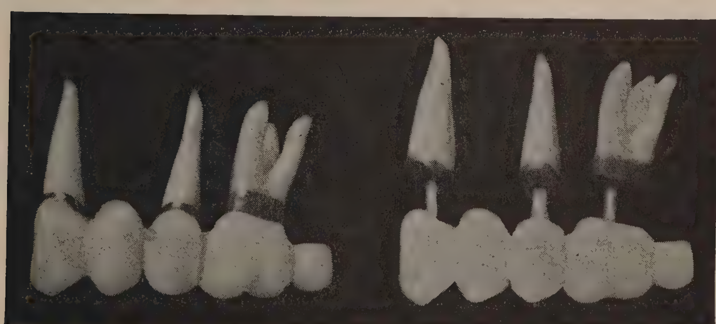
sunk inlay on the end of the bars, which may be joined to an inlay, or inlay and a post, or to a crown on the canine. With regard to the bars, the posterior



A B

ones extend to the middle of the second bicuspid, while the anterior ones meet them at that point. In this manner the maximum amount of strength is obtained, as for all practical purposes the bars are continuous. Various modifications of the foregoing will naturally suggest themselves.

Fig. 199



A B

Shows a bridge for the upper left side, consisting of the canine, bicuspids, and first molar, to which an extension is formed for the purpose of utilising the

C

whole of the articulating surface of a lower tooth. Here the anchorage is seen to consist of caps and posts, as already described, and the posts may either be solid or split. Where the latter are used, the bridge can be made removable.

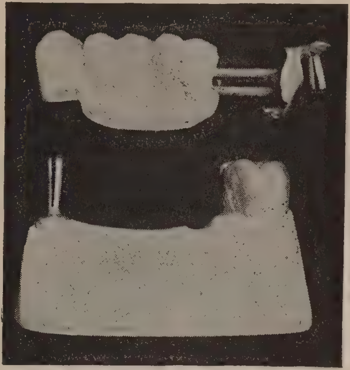
Fig. 200

Shows a removable saddle bridge for the left upper jaw, consisting of three teeth, second bicuspid and two molars.

In order to provide for the absorption of the alveolus and shrinkage of the gum, and at the same time to provide additional support for the bridge, the porcelain is shaped to fit the alveolar border. The anchorage for the anterior end of the bridge is obtained by capping and banding the bicuspid root, and employing a split post which passes through the porcelain block, the tube of which has a metal lining. The all-gold crown which supplies the anchorage for the posterior end of the bridge has a recess formed in it extending from the centre of the crown toward its anterior approximal surface, down which it is prolonged to a point a

A

little short of the gum margin. Into the bottom of the recess in the gold crown is soldered a short section of tube to take a No. 13 U. S. G. split post, and the tube is carried to the base of the pulp chamber. An inlay formed to fit the recess in the crown has cast or soldered into it the split post which enters the tube. A separate inlay joining the horizontal posts which extend through the porcelain is then soldered to the inlay



B

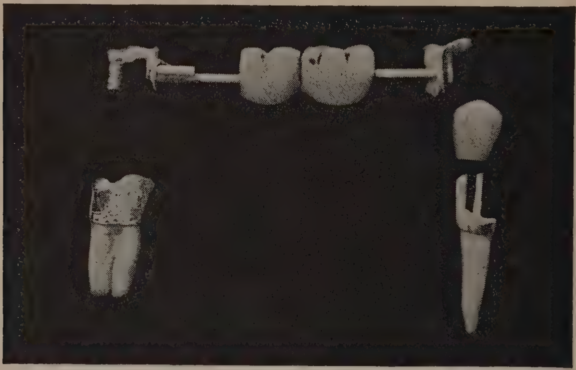
spur with split post attached, which has been already described. A perfectly secure and strong anchorage is thus obtained and one which not only permits of easy removal and replacement of the bridge, but if need arise it can readily be tightened at any time by slightly opening the split posts.

Fig. 201

A

Shows a removable bridge for the right side of the lower jaw, and consists of the three molars and second bicuspid, the latter and the third molar constituting

the abutments. The component parts of the bridge are as follows: — The body consisting of the first and second molars shaped up from the double tube rod No. 26 with the tubes horizontal; a tube tooth mounted on the bicuspid root, and an all-gold crown on the third molar. The details of the attachment are: — The all-gold crown is constructed in the same manner as described in Fig. 200 with inlay and split post; the anterior anchorage is obtained by means of a tube tooth mounted on the capped root

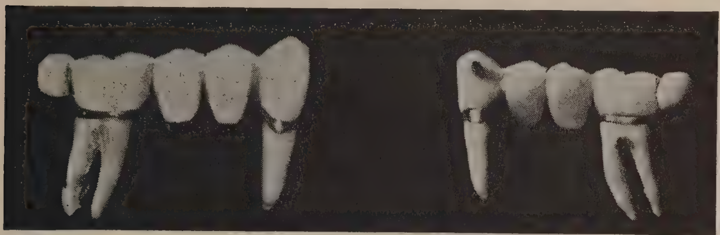


B

in the usual way, but having a groove in its posterior approximal surface extending from the base to the crown and prolonged two-thirds of the way across its surface, for the purpose of lodging and supporting a gold inlay to which a vertical split post as well as two horizontal bars which enter the porcelain molars are also attached. In addition to the vertical post carrying the single-tube crown, there is also soldered to the cap of the bicuspid root a tube about three-quarters section, with the opening presenting toward the molar, the tube having an inside diameter to take a No. 13 U. S. G. split post attached to the inlay.

Fig. 202

A. Shows a bridge for the lower right side to supply the canine, the first and second bicuspids, and first molar, with an extension from the latter to engage with the second or third molar in the upper jaw, and is formed from rod No. 26. Anchorage is obtained by means of split posts on the molar and bicuspid caps. The horizontal bars which pass through the tubes in the body of the bridge extend from the canine to the molar vertical tubes, and are



A B

not employed for the purpose of anchorage, but only for strengthening the bridge. Two short bars are also cemented into the posterior surface of the molar to the vertical tube in it, and these extend through the porcelain molar extension to which they add additional strength.

B. Shows lingual view.

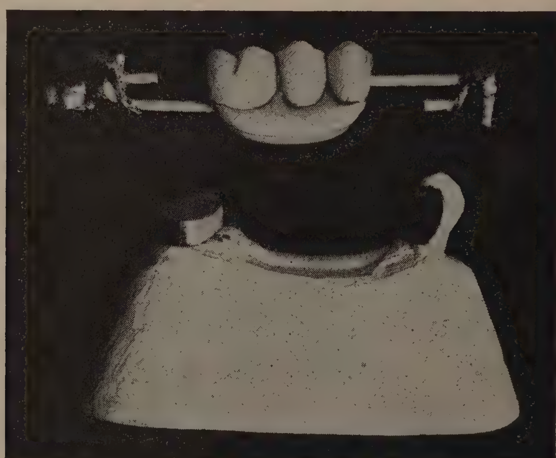
Fig. 203 A and B

A. Shows a case of a saddle bridge for the right side of the upper jaw, consisting of a porcelain block of three teeth, a molar and two bicuspids, shaped up from rod No. 27, and of an all-gold telescoping crown, which forms the posterior anchorage upon which a gold inlay is formed, carrying the horizontal bars which enter the tubes in the porcelain block.

The anterior anchorage consists of a cast inlay and tube combined, the inlay being hollowed out for the purpose of accommodating an inlay and split

A

post, to which the horizontal bars which enter the tubes in the porcelain blocks are attached. The apical end of the tube which forms part of the canine



B

inlay is closed in order to prevent moisture from penetrating through to the interior of the root.

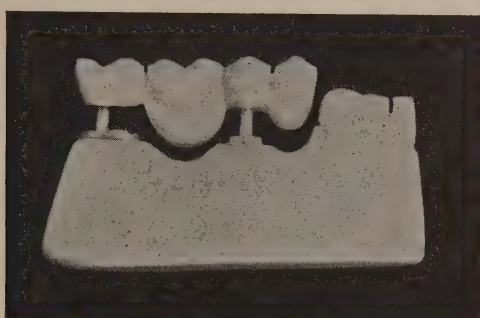
B. Lingual view showing details of construction.

Fig. 204 A and B

Shows another example of a removable bridge for the right side of the lower jaw. The anchorages consist of split posts size No. 11 U. S. G., soldered to

A

the capped roots of the second bicuspid and second molars; the bridge being shaped up from tube rod No. 26 to fit the alveolus in the interspace between

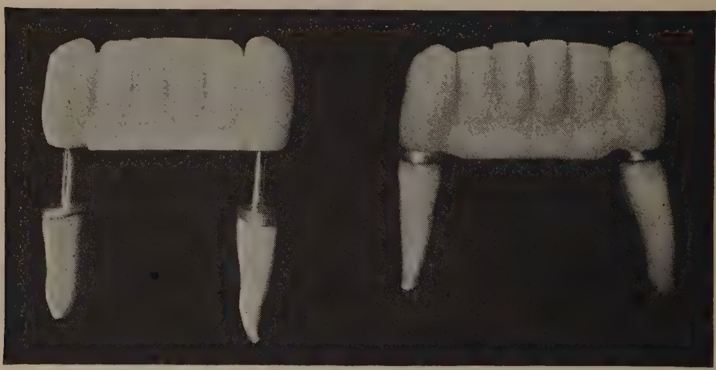


B

the molar and bicuspid, and bicuspid and canine, thereby increasing the stability of the piece. Metal tubes are cemented into the vertical porcelain tubes.

Fig. 205 A, B, C, and D

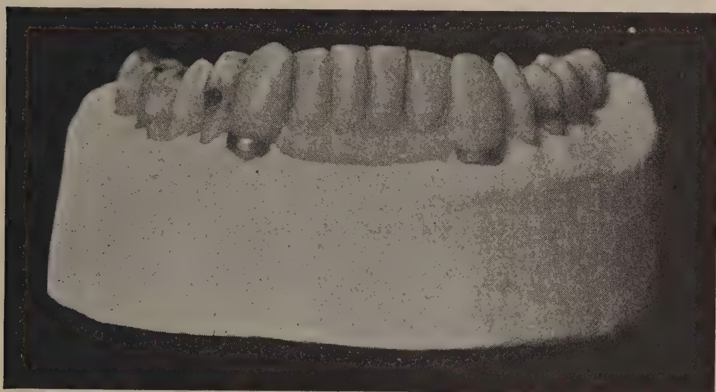
A case similar to that shown, but where the canines do not necessarily require to be crowned, is not uncommon, and when replacement of the incisors is carried out by means of a bridge, the usual method is to employ what is known as an open-faced shell crown on to each of the canines, for the purpose of obtaining anchorage, and to these are soldered the intervening incisor facings, which in turn are joined on to the



A B

canine shell crowns and the whole united together with solder. Such a piece is not only unsightly because of the amount of gold shown, but it is also very inartistic and difficult to keep clean. There are several ways in which such a case can be better dealt with by the use of tube rods. The first of these is in the manner shown, and it presupposes decay of a more or less extensive character in the canines, which points to the necessity for crowning them. Under these circumstances, then, the canine roots should be capped and banded in the usual way, and split posts employed in a manner similar to that already described in connection with other cases.

An impression and bite should now be taken, and having obtained a model with the caps in position the next step is to make certain that the split posts to carry the bridge are exactly parallel. A section of tube rod No. 26 should next be fitted into the space between the bicuspids on either side, and in order to do so, the caps should be removed from the model which has been previously hardened. After the section of tube rod has been roughly shaped to fit



C

the model, the caps and posts should be replaced and the position for the tubes which are to be drilled through the porcelain carefully noted; this can be done by touching the projecting ends of the split posts with vermilion paint, and holding the block in position note where the paint touches it. The parallel tubes for the posts should now be drilled through the block, which should then be ground on its under surface to fit the model, and after this has been done metal tubes should be fitted to the tubes, but not cemented into the porcelain tubes at this stage if gum enamel is to be fused on to the front of the porcelain gum.

The shaping up of the teeth should now be carried out in the manner described in Chapter XII, page 237. If shading of the teeth is required, this can be done either when the gum enamel is added, or as a separate operation.

Instead of tubes drilled through the porcelain,

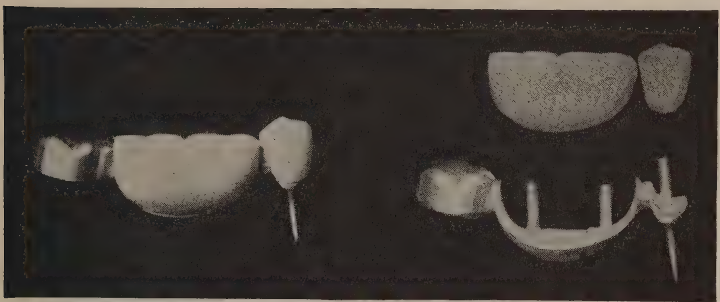
D

tube inlays may be used in the manner already described.

Fig. 206

Illustrates the use of an old-time gum tube section of two molar teeth, and serves to show how these sections could be utilised in some cases to take the place of fused porcelain, or sections formed from porcelain rods, with advantage in regard to time-saving and doubtless in other ways. The illustrations also show that the bridge is not a saddle, but a bar, and that the bar is triangular in section with

the apex end lightly in contact with the surface of the gum. The purpose which this is meant to serve is to obtain a surface which can be readily reached by the tooth-brush through its whole length both on its buccal and lingual surfaces. The anterior anchorage,



A B

as will be seen, is by means of a capped second lower bicuspid, and a point to be noted in this connection is that provision is made for the employment of a tube tooth instead of a porcelain facing. By means of an extension of the bar on to the top of the bicuspid cap, the impact of the bite is transferred to the long axis of the root, and not mainly on to the facing. This is accomplished without any material sacrifice of strength in the tube tooth, while in the event of fracture the crown can be replaced without the removal of the bridge.

C

The foregoing case shows the advantage which would be derived in the event of a revival in the manufacture of gum tube sections — which it is sincerely to be hoped will take place — a valuable addition would be made to the materials available for the purpose of forming saddle bridges which would be not only stronger than

fused porcelain, but would also save much valuable time in building up and fusing. Moreover, these sections could also be modified by the addition of fused porcelain to meet the necessities of individual cases.

Fig. 207

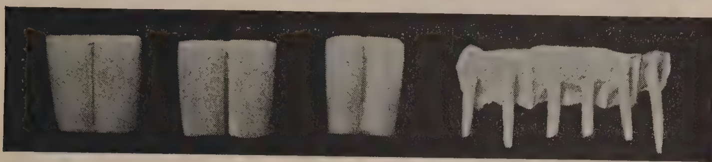
Shows a case where two of the lower incisors have been lost owing to a recession of the gum or some other cause, and is generally associated with looseness of the adjoining teeth. The treatment of such

A

B

a case when carried out by means of a splint carrying soldered teeth to fill the space, and at the same time support the remaining teeth, is open to several objections, the principal of which is the danger of fracture of the porcelain facings. By the employment of two tube teeth shaped up from a porcelain rod in the manner shown in the figure, it will be seen that this danger can be avoided, the splint being carried across the lingual surface of the remaining teeth, which are shaped in order to allow of sufficient gold for the bar which is anchored into their lingual surfaces. It will be seen that the pins which carry the teeth are soldered to the under

side of the splint, and that the porcelain has been ground away sufficiently to allow of ample strength of gold without unduly weakening the teeth, while a little extra has been ground off the approximal



C D

surfaces of the adjoining teeth without involving their labial surfaces; thus giving the maximum strength of metal at the part where it is most required. Such cases may also be dealt with by means of porcelain rods used horizontally, and Fig. 219 shows bridges suitable for use in this way.

A. Shows model with bridge and splint in position.

B. Splint raised showing details of construction.

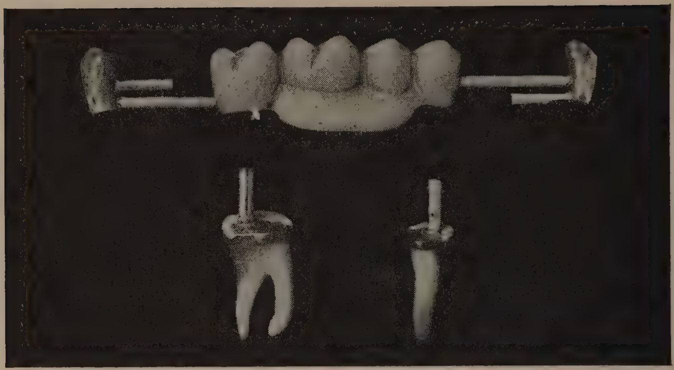
C. Shows stages in the shaping up of porcelain bridge:—

D. Shows gold splint.

Fig. 208

A

Shows a saddle bridge for the lower right side consisting of four teeth, two bicuspids and two

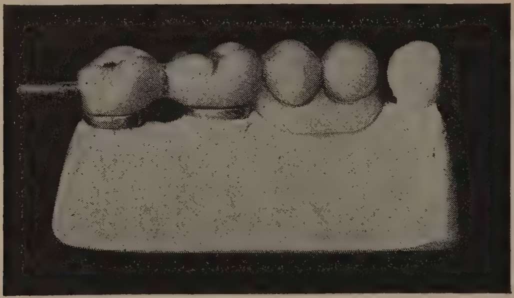


B

molars, formed from rod No. 27. Anchorage is by means of caps and bands with split posts to enter tubed inlays at either end of the bridge.

Fig. 209

Shows an all-porcelain extension bridge for the upper left side formed from rod No. 26, supplying both bicuspids and first and second molars. It

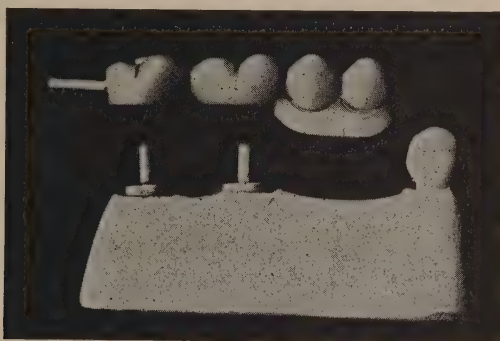


A

will be observed that the absorption of the alveolus due to the loss of the bicuspid roots is made good by the porcelain saddle, which at the same time affords a sufficient bearing for the anterior end of the

bridge. If need be, additional support could be obtained by means of a spur resting on an inlay in the disto-lingual surface of the canine, or by one of the anchorages which has already been described.

The anchorage by means of split posts attached to the molar caps, provides a secure and rigid attachment, with at the same time provision for easy removal, and if occasion arises, for readily tightening the piece by slightly opening the split posts. Here



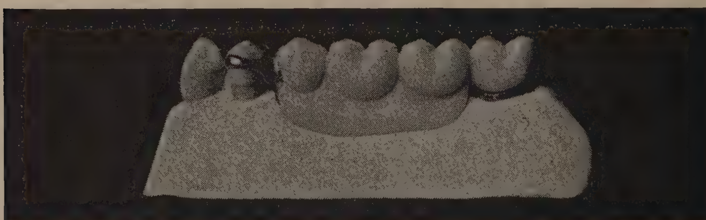
B

the addition of the metal tubes lining the porcelain tubes in the molar crowns may be adopted with advantage. It will be observed that the rod has been used with its broadest section toward the gum in order to obtain the maximum area of saddle. Had a greater length of tooth or depth of saddle been required, rod No. 39 would have been substituted.

Fig. 210

Shows a lower left saddle bridge formed from tube rod No. 27, consisting of the three molars and the second bicuspid. The latter and also the two anterior molars, form part of the porcelain saddle

which rests on the gum. Anchorage of the anterior end of the bridge is by means of a gold band with occlusal rest for the first bicuspid and is soldered to a gold inlay carrying horizontal bars which pass through the body of the bridge and terminate in contact with the vertical gold tube cemented into the third molar. The molar is capped and has a post for anchorage into the canal of the posterior root, while the cap carries a split post which passes through the tube in the third molar, and so com-



A

pletes the anchorage of the posterior end of the bridge.

This bridge illustrates the doubt which exists as to whether certain cases should be classed as plates, or bridges, or plate-bridges.

Fig. 211

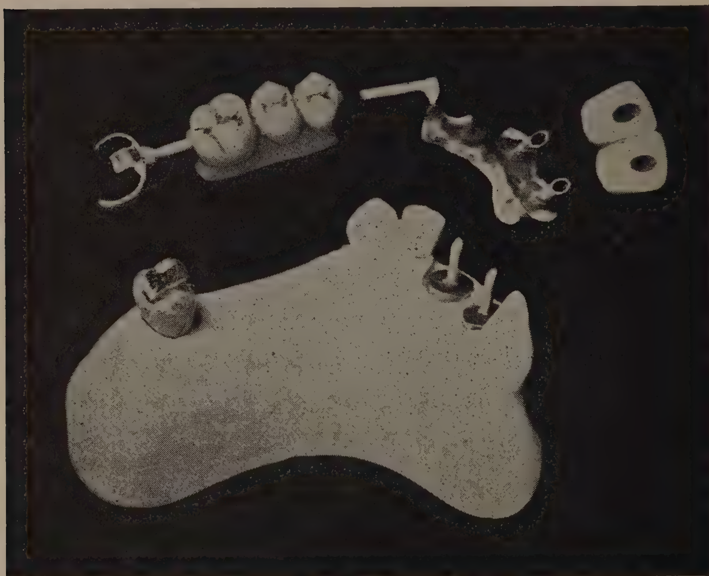
Illustrates a type of removable bridge belonging to the class known as "interrupted" bridges, this description being generally applied to those cases in which one or more natural teeth, which are not necessary for use as abutments, intervene in such a way that they cause an interruption or break in the continuity of the parts of the bridge. It will be seen that in the case under consideration, the right

upper bicuspids and first molar are missing, and that the crowns of the central incisors as well as those of the bicuspids and molar require replacing. The following description will doubtless serve to convey a sufficiently clear idea of the procedure followed: — The porcelain parts of the bridge consist of the two bicuspids and the first molar shaped up from the double-tube rod No. 27 to fit the alveolar border while the two central incisors are shaped up

A

from tube rod No. 30. These parts are united by means of a narrow gold plate extending on to and covering the capped central incisor roots. An inlay formed in the anterior approximal surface of the bicuspid to which the horizontal bars are attached is soldered to the gold plate. The illustration shows that the roots are capped and banded and have split posts soldered to them as for an ordinary tube crown, and that the anterior anchorage of the bridge is secured by means of tube posts soldered to the plate through which pass the split posts attached to the caps of the central incisors, the tube

in the tube porcelain crowns being enlarged for the purpose. The upper right molar forming the posterior attachment is provided with an all-gold crown which has a recess formed in it for the accom-



B

modation of an occlusal rest which forms part of the clasp attached to the inlay and horizontal bars.

Fig. 212

Shows two lower molar crowns joined together and shaped up from curved block No. 34, forming a bridge for a type of case which is by no means infrequently met with. It serves also to direct attention to some of the advantages to be obtained by the use of curved blocks which have not hitherto been pointed out; thus they enable the super-structure of such a bridge as that shown to be

formed far more quickly than by any of the recognised methods.

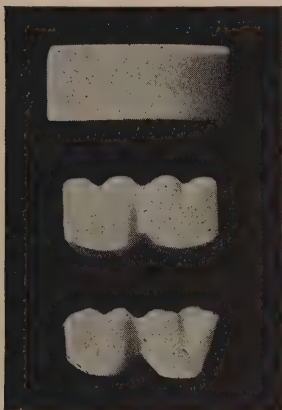
A. Shows curved block No. 34.

B. First stage in shaping up — 2 mins.

A

B

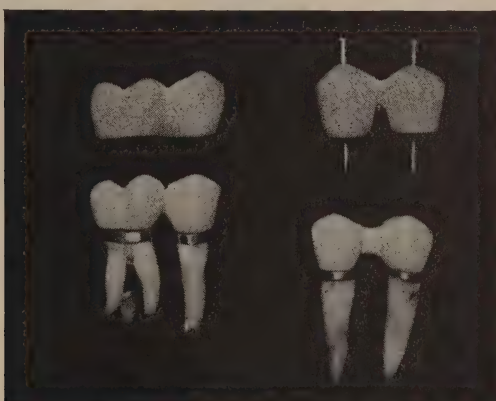
C



D

C. Second stage—3 mins. Time for shaping up, but not including time for smoothing, polishing or fitting to caps or bite—7 mins. Wheel used 4 inch, grit 100.

E



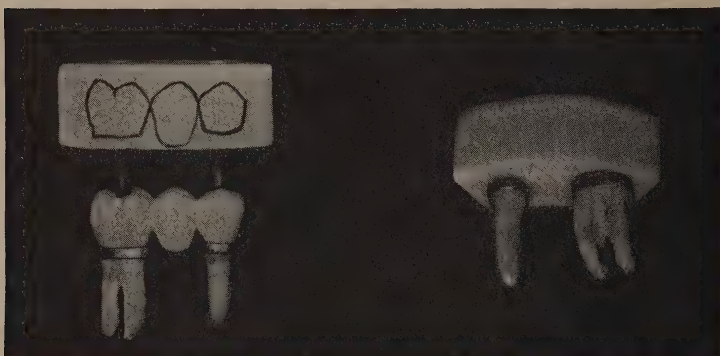
D. Finished crowns. Total time for fitting crowns to caps, smoothing and polishing — 60 mins.

E. Two crowns joined together in this way may

be employed to act as a splint and bridge combined in a case where the molars are loose and somewhat apart.

Fig. 213

Figs. A. and B. show an upper left removable bridge of three teeth — two biscupids and a molar — formed from curved block No. 33. The outline of the teeth is shown sketched on the block, and illustrates the means which should be adopted in



A B

all cases by those who have not had much experience in tooth shaping, as by following this plan a great deal of uncertainty with regard to where to grind is done away with.

Anchorage in the specimen shown is by means of split posts, and metal tubes are cemented into the tubes in the porcelain block.

Fig. 214

Shows a small upper removable bridge for the left side, of three teeth — canine and bicuspids — shaped up from curved block No. 34. Anchorage

by means of capped and banded roots, and split posts.

Fig. 215

A and B show a labial and lingual view of two upper removable bridges shaped up from curved tube block No. 34. From each block is formed a

A B

central, lateral, and canine. A reference to Fig. 23 will show that these blocks can be shaped up to suit the broadest as well as the narrowest arch.

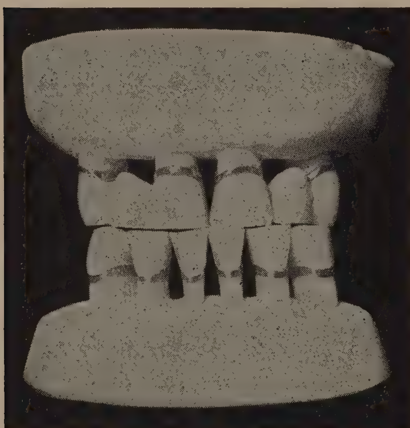
Fig. 216

Edge to edge bite

Shows a method of dealing with a case of extensive erosion and abrasion of the upper and lower incisors.

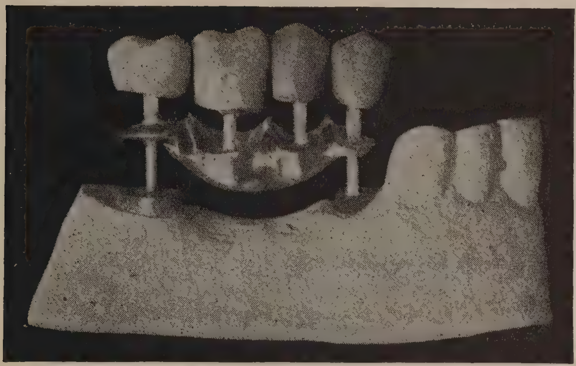
Some of the causes which give rise to this condition have been described in Chapter XI, where it has been shown that it is usually accompanied by the

loss of some of the grinding teeth, and extensive wearing down of the remaining ones. In the majority of cases this necessitates opening the bite, either by crowning the grinding teeth, by bridging, by plates, or by a combination of these methods in addition to crowning the incisors, in order to restore function as well as appearance. The ordinary means by which this is usually accomplished is satisfactory enough as far as the utility is concerned, but from an artistic point of view the results are in most cases far below the standard which one should aim at, but by the employment of tube blocks and tube teeth in a manner similar to that shown in the accompanying illustration, restoration of function in addition to the maximum improvement in appearance can be obtained. This also demands opening the bite by means of crowns, bridges, or plates, or a combination of those means. In the case shown, the restoration of the upper incisors and canines is carried out by means of curved tube blocks No. 33, shaped up in the manner described and each of the sections right and left may be made either fixed or removable. If they are to be made removable, metal tubes should be cemented into the tubes in the porcelain blocks, and split posts instead of solid ones soldered to the caps.



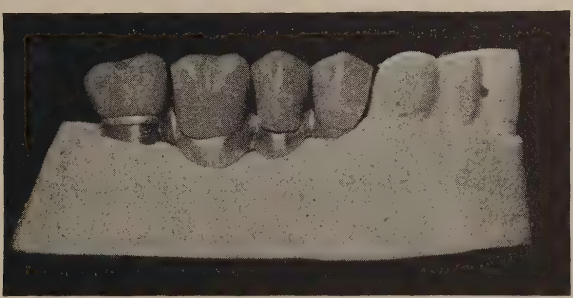
The lower teeth are dealt with by means of individual tube crowns, but if one or more of the incisor roots are missing, other methods may be used, and Figs. 182 and 205 offer suggestions to this end.

Fig. 217



A

Shows a case of an upper left saddle bridge with a cast metal base, where single tube teeth have been



B

employed, and while it serves the purpose of exhibiting the use of these teeth, it also illustrates another method of dealing with divergent roots.

Fig. 218

Shows a lower removable vulcanite bridge with tube teeth and split post and tube anchorage. The details of its construction are briefly as follows: — The molar and bicuspid roots are capped and banded in the usual way, and central split posts attached to them. Over the split posts gold tubes are placed,

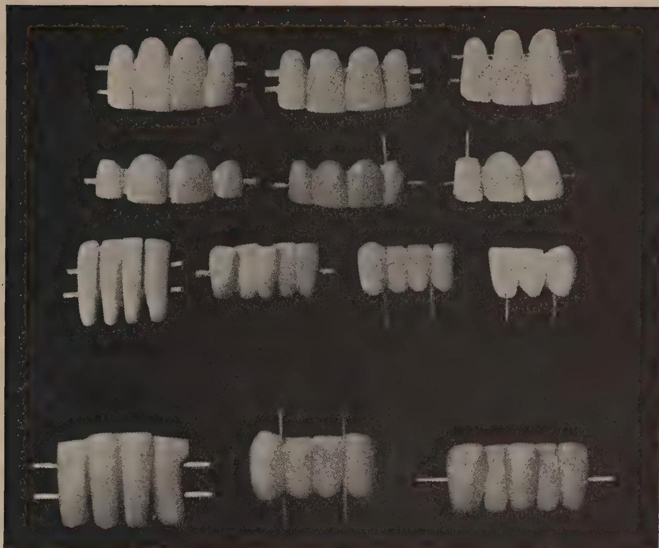
and these are soldered to a horizontal bar $13\frac{1}{2}$ U. S. G., which joins them. At the same time, vertical pins are soldered to the bar for the purpose of affording anchorage for the second bicuspid and first molar. This forms a framework for the attachment of the vulcanite carrying the tube teeth. The tubes of the first bicuspid and second molar are reamed out with a diamond reamer to permit of them fitting over the tube and split post, and in order to allow of a sufficient body of vulcanite underneath them to cover the caps, sufficient is ground off the base, except on the buccal side.

Fig. 219

A. Shows a selection of upper and lower bridges formed from single and double tube rods.

B. Shows incisive edges of some of the above bridges which shows the amount of irregularity which can be obtained.

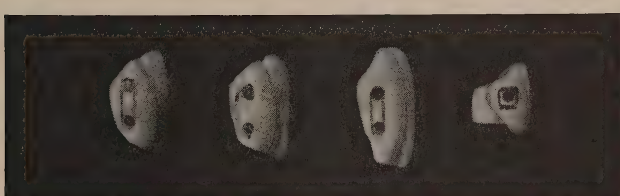
C. Shows end view of some of above with positions of inlays outlined. Most of these specimens were shaped up by young pupils.



A

D[I]. Shows a block of 6 upper front teeth shaped up from tube rod No. 27.

B

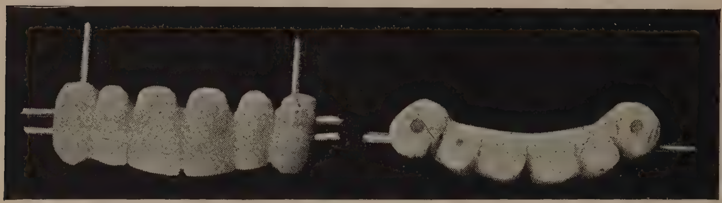


C

D[II]. Shows basal view of same block.

Though replacement of the whole of the anterior

teeth by means of a single block such as that shown would be more satisfactorily accomplished by



D

means of curved blocks, the specimen is an excellent example of the value of tube rods for teaching purposes.

CHAPTER XIV

THE USE OF TUBE TEETH IN PLATE WORK

IT is unnecessary to restate the whole of the evidence which exists with regard to the early use of tube teeth in plate work; but it is clear that they were the earliest form of teeth used, and that their popularity was obscured by the rapid development which took place in the manufacture of pin teeth on the introduction of vulcanite. Their eclipse, however, was only temporary, and their rapid advance in popularity under a variety of new names or titles is seen in the steady increase in the number of new forms of pinless teeth and detached post crowns.

In dealing with the use of tube teeth in plate work, no consideration will be given to the construction of metal plates, but attention directed at once to the fitting of tube teeth, and it is to be understood that struck — not cast — plates are here referred to, although much better results are now obtained by means of the casting process than some writers of acknowledged standing seem to recognise.

The use of tube teeth calls for the addition of a few simple hand tools which had best be described here. These are: —

(1) A countersinker for clearing away the bur which forms upon the end of the tube when ground and for slightly enlarging the orifice of the tube at

its base. This is only necessary when platinum tube teeth are employed. When non-platinum tube teeth are used, Butler's points answer best. The steel countersinker may be made from an old excavator handle, and should be large enough to ob-

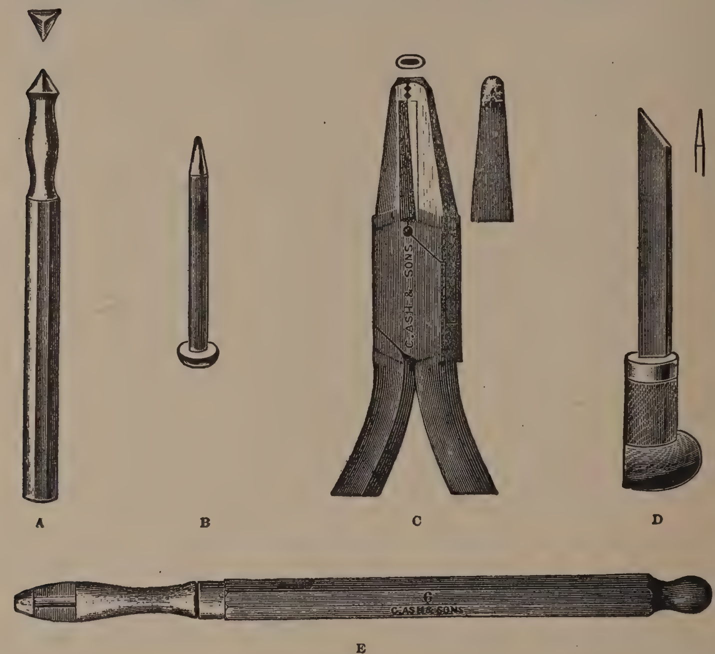


FIG. 220. Shows some simple hand tools used in the work. A, Countersinker. B, Marker. C, Roughing pliers. D, Sharp-pointed graver. E, Pin-bender.

viate any danger of splintering the tooth by forcing it too far into the tube.

(2) A tube file to remove débris from the tube after grinding platinum tube teeth. This should follow the use of the countersinker, and before trying the tooth on the pin.

(3) A marker. This is a piece of straight cylindrical steel wire. It should fit the tube of the tooth exactly, and have one end sharpened into a three-

sided point. Its use is to mark exactly the position of the centre of the pin hole when the tooth is mounted. It must therefore fit the tube easily, but not too loosely.

(4) A pair of roughing pliers. These have a longitudinal groove in them for holding the pin while it is being inserted into its socket in the plate.

(5) A sharp pointed graver used in plate work for deepening the hole made by the marker.

(6) A length of wire — gold pin wire.

(7) A quantity of paint made by mixing vermilion and olive oil. Too much oil makes a paint that will not easily adhere to the part to which it is applied, while on the other hand too much vermilion makes the paint thick, with the result that false marks are produced. Other pigments such as rouge have been suggested, also a blue pencil or crayon, but on the whole vermilion will be found best.

(8) A drill-stock and drill. The drill must be a shade smaller than the size of the wire used for the posts.

(9) A dental engine.

(10) A pin bender.

The respective uses of the above appliances will be described when explaining the method of mounting tube teeth.

The fitting of tube teeth to a metal plate is similar to the method described in connection with fitting a tube tooth to a capped root, but in order to make the various steps clear, a description will be given of an upper case where the third molars and canines alone are left standing, and where the amount of absorption is not excessive. Suitable tube teeth

should be chosen for the incisors, care being taken that they are long enough and of the right width to fill the space. The colour, however, is the most important matter, as it will be seen from what has already been said in connection with the subject of shaping and grinding, that teeth of whatever size, provided they are large enough and of the right colour, can be shaped to the requirements of any case. The first step after having chosen the teeth is to rough-fit the two central incisors to the plate, and having removed all débris from the tubes, stick the two incisors carefully in position on to the plate by means of sticky wax applied to their lingual surfaces, then pass the marker down the tube of each tooth in turn (Fig. 221), and press the point into the plate while the marker is being rotated. While doing so, the teeth should be firmly held in place with the forefinger and thumb of the left hand, so as to steady them and prevent their position from being altered. Another way of marking the pins is to touch the end of a marker with vermilion paint, and for this purpose a piece of pin wire tapered and rounded at the point answers well. This should be passed down through the tube, where, of course, it will show a red point on the plate. The operator being satisfied that the position of each pin has been duly marked, the teeth should be removed from the plate by slightly heating it over a Bunsen flame

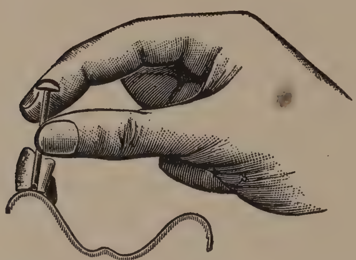


Fig. 221. Method of marking position of each tooth.

and clearing away all traces of wax from plate and teeth. Having replaced the plate upon the model, hold it firmly in position with the left hand, while resting the model against the bench-block, and with the graver deepen the marks previously made. The holes for the pins should next be drilled, and in order to do this use a drill a size smaller than the pin wire. Pliers are sold for the purpose of punching these holes, but they should not be used, especially by the inexperienced, as their use involves a danger of bending the plate. When the pin hole has to be made on a steeply sloping part of the plate and not on the top of the ridge, considerable care and skill are required to prevent fixing the position of the pin too far down on the slope. In order to avoid this, a good plan is to use a small drill, and afterwards enlarge the hole for the pin by means of the broach, using the tooth as a guide. The broach used should be either a size smaller at its thickest part than the pin wire, or have a mark made on it to indicate the point beyond which it cannot be used without danger of making the hole too large or of splitting the tooth. The bur made by the drill and broach should be removed by means of the scraper or graver, and the pin-hole slightly countersunk on the palatal surface. A length of pin wire is now taken and passed through the tooth, and a piece a little longer than the tube cut off with the cutting pliers. Next grasp the pin with a pair of roughing pliers, file the end of it to a three- or four-sided shape, and slightly taper it to enable it to hold firmly in the hole during the soldering process. All pins should be prepared in this way and placed on the bench, each one opposite its corresponding tooth. The pin-holes

are now painted with borax, as well as the pins. Grasp each pin with the roughing pliers, and firmly force it into the pin-hole in the plate, taking care to give it the right direction — and until much experience has been gained it is best to solder not more than two to four pins at one time, but the experienced workman will have little difficulty in soldering as many pins as may be required at once. Having satisfactorily fixed the pins in place, proceed to solder them in the following way: Place a small piece of solder on the plate, touching each pin, then place the plate on the soldering block, or on a good-sized piece of asbestos fibre, where it will rest steadily, taking care that the pin or pins to be soldered are in a vertical position. Now heat up the plate carefully and slowly with the blowpipe, so that the borax in fusing does not displace the solder. The plate must be heated up until the solder flows, and should it be found on examination of the palatal surface that the solder has not flowed through, heat up the plate thoroughly, centre the flame on to the ends of the pins on the palatal surface, and carefully draw the solder through. In soldering the pins to the plate, a lower grade of solder may be employed than has been used in any other part of the work, because this is usually the last soldering that requires to be done, except the case is one in which flat teeth are used (Fig. 222) when they are generally soldered last, and the pins for the tube teeth are protected by investment. It is a matter of considerable importance to have the pieces of solder of the right size. Too much solder will interfere with letting the tooth down over it, and have to be cut away, while too little will leave the attachment of the

pins to the plate too weak. The correct amount should be sufficient to solder the pin to the plate and surround it on its lingual surface with a slightly bevelled collar, which will add to its strength. The beginner invariably errs in using too much rather than too little solder.

There are other methods employed of uniting the

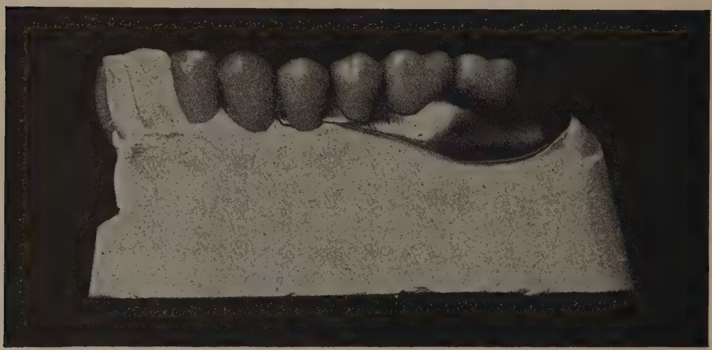
A

Fig. 222. A, Shows partial upper gold plate, incisors and canines. Plain teeth backed and soldered. Molars and bicuspids tube teeth.

pins to the plates, such as investing and then soldering, or tying them to place with binding wire. The method given is, however, the simplest, and yields entirely satisfactory results.

The plate should now be boiled in pickle to remove the borax, and any excess of solder or slight projection of the pin on the palatal surface should be cut off with a half-round graver, or ground off with a

small stone so that the plate may go home to place on the model. The teeth should now be tried on the pins to insure that their direction is right, as during the soldering process this may have been slightly altered. But if that end of the pin attached to the plate is right, any alteration which may have taken place in the soldering can only affect its direction, and this may be rectified by grasping the pin with the pin-bender, or a pair of pliers, close to the



B

FIG. 222. B, Shows labio-buccal view.

surface of the plate, while it is held firmly on the model, and bending it into line.

Their free ends may now be cut down to the bite. The steel countersinker may now be used to countersink the base of the platinum tube tooth, or this may be done with a Butler's point in the case of a non-platinum tube tooth. The tube centrals should now be let farther down to fit the plate, and the lateral incisors treated in precisely the same way as the centrals. If the teeth are to be set on the gum and not on the plate, the latter should be cut away as in Fig. 223, allowing the porcelain to project about

one-sixteenth of an inch beyond the edge of the gold. Unless the teeth are too narrow in the base, this will not interfere with the strength of the attachment between the pin and the plate. The teeth should be ground in the manner described in connection with fitting tube crowns, until they accurately fit the plate, and their cervical labial margins are adapted in like manner to the models, the operator taking care in doing so to note that they are left to a proper length and made to conform to the bite,

FIG. 223. Central fitted to gum with plate cut away.

while the pins are at the same time filed or ground flush with the lingual surface of the teeth. The teeth cannot be considered as fitted until there is not the slightest visible space between them and the plate. In fact, the gold should appear as if it were cast on to the tooth. Accuracy with regard to the fit of the teeth to the plate not only shows workmanlike skill, but has the practical advantage of lessening the risk of the rotary motion of the jaw, loosening the teeth, a possible accident which might occur if they are not steady on the pins.

After the pins have been soldered to the plate, and the fitting of the teeth is being proceeded with, one or more of them may be found to "bind" as

they touch each other, and this will necessitate a little of the contour being ground off; or the reverse may be the case, and some of the teeth may not touch, and adjustment of the pins will be required to obtain points of contact.

Having fine-fitted the teeth to the plate, their ground edges will be a little rough, and these should

A

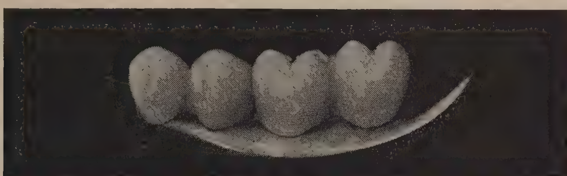
FIG. 224. A, Shows partial lower gold plate with single tube teeth on right side. Molars and bicuspids shaped up in pairs from rod No. 31 on the left side.

be smoothed off by slightly touching them against the sides of a fine and fast-running wheel.

The fitting of the grinding teeth should be carried out in the same manner as already described in connection with the incisors, but some operators prefer to have them touch along their approximal surface from the plate to the grinding surface, as thereby particles of food do not easily lodge between them, and there is much to be said in favour of this method, which is easily carried out in the case of

single tube teeth, and more easily still when two or more tube teeth are shaped up from a double tubed rod or curved block (Fig. 224), where a joint similar to that of a gum tooth section may be formed.

When a tube tooth has to be fitted against a clasp, it is well to reduce it to nearly its proper length before grinding off the side to fit the clasp, and only about half of what will require to be ground off should be removed before the pin is soldered to the plate. Further, in marking the position for the pin, the base of the tooth should be held close up to the clasp at its neck, unless it be a type of tube



B

FIG. 224. B, Shows buccal view of left side showing pairs of molars and bicuspids with parallel joint as in gum sections.

tooth much contracted at the neck, as some tube bicuspids are. This will incline the tooth a little away from the clasped one. After the pin has been soldered to the plate, the former should be bent slightly toward the clasped tooth, when it will be found that the tooth will not go home to place, but press against the clasp. Mark where it rests, and grind carefully away, taking care not to grind away from the neck of the tooth but toward it. Bend the post still farther toward the clasped tooth, and repeat the process of grinding and bending the post until the tooth is in proper line, when it will be found to lie closely against the clasp. Figs. 225 to 230 show some typical tube cases.

A

FIG. 225. A, Model showing case suitable for bridge, while patient preferred plate. Canine devitalized; cap and tube shown in place. Molar with gold inlay hollowed out to accommodate spur on plate.

B

FIG. 225. B, Small gold plate with three tube bicuspids, pin attached to plate to enter canine tube. (Pin not shown in illustration.)

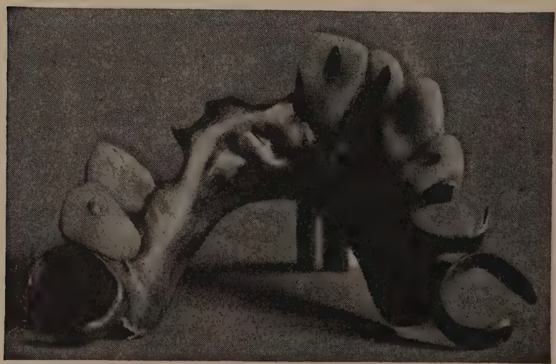


FIG. 226. Shows partial gold plate with tube teeth. Close bite.

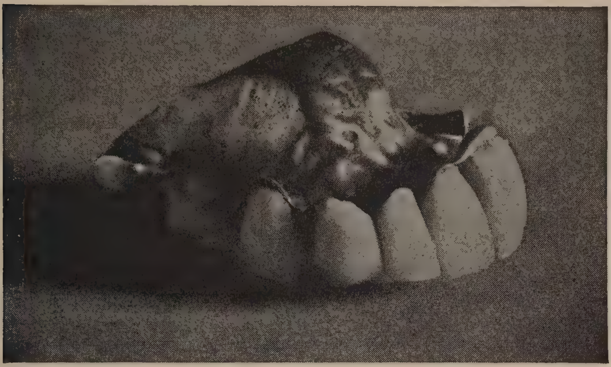


FIG. 227. Partial upper gold plate with tube teeth; labial view.

FIG. 228. Lingual view of plate in preceding illustration.

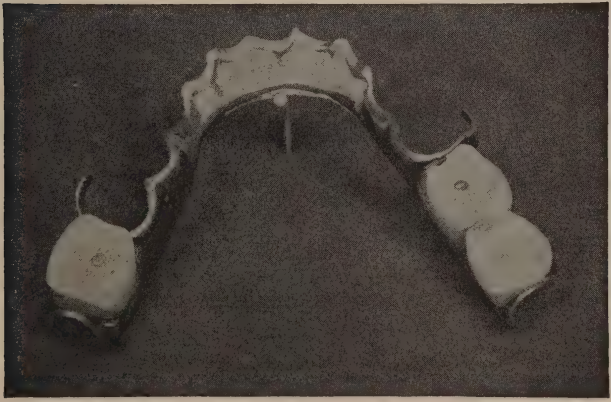
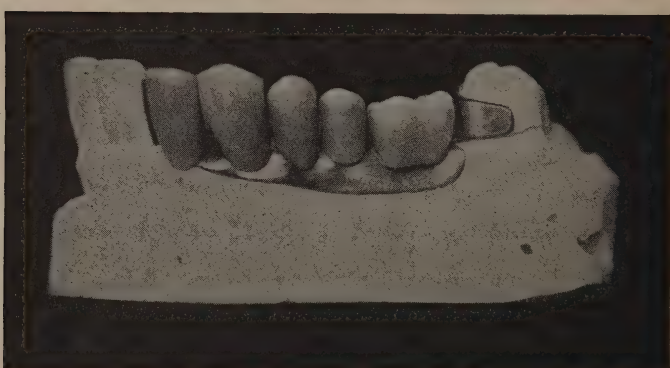


FIG. 229. Partial lower gold plate.

A

FIG. 230. A, Shows partial upper gold plate with tube teeth. Close bite. Palatine view.



B

FIG. 230. B, Shows labio-buccal view.

Double Tubed Rods

The use of double-tubed rods has been dealt with in treating of crown work, and the advantages claimed for them in that connection apply also in certain cases of plate work. The class of case most suitable for their use is where the bite is abnormally close. The method of fitting them is in all respects similar to that already described in connection with single-tube teeth or tube rods, and the only point which calls for special mention is the method of fixing the pins to the plate. There are two methods whereby this may be done, and that which calls for the least amount of skill and which yields the desired results with very little labour will be first described. After the block has been fitted and cut off to the required length, it should be fixed in position on the plate by means of sticky-wax, the position of the pin determined as before described, the hole drilled, and the pin soldered, the pin nearest the front being the first to be done. If by chance the position of the porcelain block should be found to be a trifle too far away from the tooth anterior to it after the post has been soldered, this can easily be remedied by cutting off the pin and resoldering a fresh one. If, on the other hand, it should be a trifle too close to the adjoining tooth or space, sufficient of the excess can be ground off; but with ordinary care such a mishap should be impossible. Special care should be observed to make certain that the direction of the first pin is correct, and that it has been placed vertically, as it is important that no subsequent bending of the pin should be necessary. Having now fixed the first pin satisfactorily, the

second or posterior one is adjusted, as in the case of a single tooth.

The second method is to adjust and solder both pins at once, and while this is very easily done, it requires more care and skill than the method already described. The block is to be fixed as before, and the position of both pins carefully marked on the plate. The pin for the first should be firmly fixed by forcing it to place with the roughing-pliers, or a temporary pin employed, and the hole for the second one enlarged with the broach passed through the tube, which thus acts as a guide. Having prepared the posts and their sockets, adjust them so that the block can be slipped off and on readily, then solder them without investing.

The subsequent steps are the same as those already described in crown work, and Figs. 127, 128, and 129 shows molars and bicuspids formed from double tube rods.

Repairs in Plate Work

The repairing of a gold plate with tube teeth is an easier matter than where the teeth are soldered, as the teeth, being usually fixed on with sulphur, can be easily removed, and in consequence the danger of fracture while soldering is obviated, while at the same time the investment can be much more quickly heated up, and in certain cases can be dispensed with altogether. In cases of close bite and where there are several detached teeth, tube teeth are peculiarly well suited, for the above reasons, as well as for others stated elsewhere.

In the case of replacement of a broken tooth only, the procedure is similar to that of fitting a tube tooth as described in Chapter XI.

CHAPTER XV

THE USE OF TUBE TEETH, GUM TUBE TEETH AND SECTIONS IN VULCANITE WORK

IN dealing with this subject the writer proposes to describe briefly the use of the above-named teeth in connection with vulcanite as a base, as well as combination dentures, which include metal plates — usually gold — with vulcanite attachments, vulcanite plates with metal linings, etc. The suitability of these teeth for use in the above manner will be apparent to those who have followed the argument advanced in their favour, and it is therefore unnecessary to elaborate these further, though additional confirmation may be obtained from the accompanying illustrations.

With regard to the selection of suitable teeth, this presents fewer difficulties than in the case of the ordinary plain teeth, or indeed of teeth of any other type, for various reasons, one of which is that the method of attachment permits of a much greater amount being ground off without the danger of impairing or destroying the anchorage.

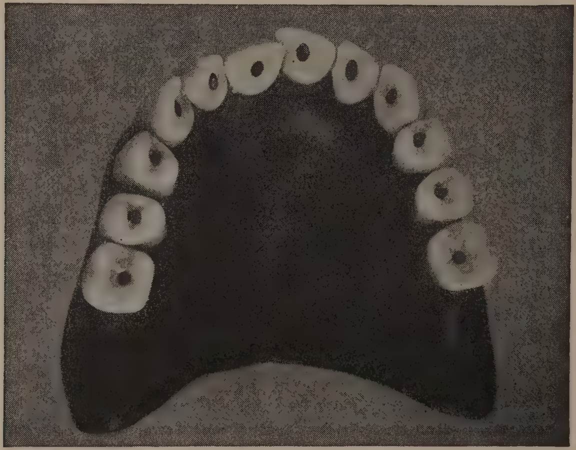
The method employed in arranging tube teeth is similar to that followed in connection with other forms. They have, however, this advantage, that they allow of greater freedom in the matter of arrangement than plain teeth, for the reason that they can be set at a greater angle to one another

without the risk of showing vulcanite (Figs. 231, and 232), and so obtain the advantage possessed by

A

FIG. 231. A Shows front view.

teeth which do not require a vulcanite or metal backing, their closest rivals in this respect being countersunk teeth. The teeth are set up in the

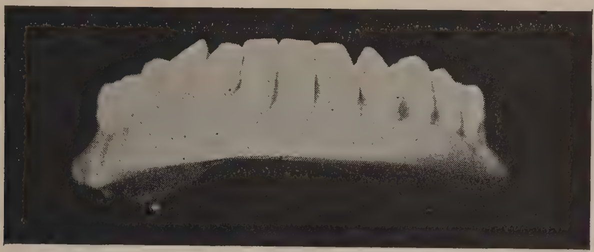


B

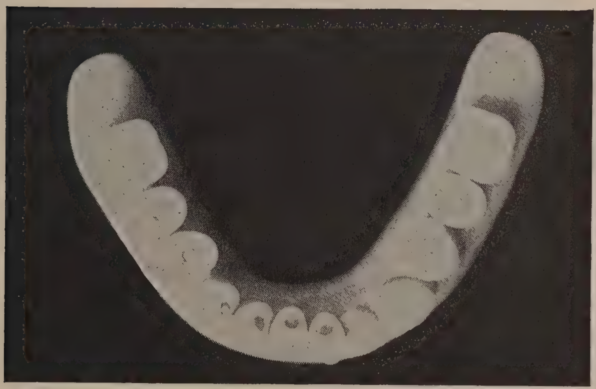
FIG. 231. B, Shows Incisive view.

usual way, but before the case is flasked the tubes should be filled with wax, in order to prevent plaster

from flowing into them while the case is being invested. Fig. 233 shows an upper case ready for packing, and before doing so suitable posts (Fig. 234) such as those supplied by Messrs Ash of London,[1] should be cut to the proper length and fitted



A



B

FIG. 232. Lower vulcanite plate with tube teeth. A, Front view. B, Incisive view.

to the tubes. Before fixing them in place, a very small piece of rubber may be packed into the tubes and the posts slightly heated, and pressed home to place; this insures the posts being covered with rubber, and a secure attachment being obtained.

[1] These posts are made of aluminium alloy, which does not oxidize during the vulcanizing process.

The foregoing is the method employed in most cases, but certain conditions may exist which will necessitate modifications. If, for instance, it is seen

FIG. 233. Upper case ready for packing.

when the teeth are being set up that there is apparently too little room for the headed posts between the base of the teeth and the model, sufficient space may be obtained by hollowing out the base of the teeth, which should be set up with the pins in place, before investing. In certain partial cases the teeth cannot be brought away in the upper half of the flask, but must be covered by the investment in the lower half. Here a difficulty may arise with regard to the rubber not flowing around the posts in the tubes. This may be overcome by filing a little off one side of each of the posts to allow the rubber to fill the

FIG. 234. Ash's aluminum alloy post, roughened.

tubes, or by filling the tubes and surrounding the heads of the posts with rubber before investing, as already described, when most or all of the rubber surrounding the heads of the pins may be removed and replaced by fresh rubber while the case is being packed; or the teeth may be removed before the case is invested, and in order to facilitate their removal without altering the position of the posts, the base of the teeth should be oiled to prevent the wax from sticking to them. The case should then be invested without the teeth, the pins being securely held in the investment, and after being vulcanised the plate should be finished in the usual way, the teeth being either cemented to place before the case is finished or stuck on temporarily with hard wax during the finishing process, otherwise the edges of the vulcanite sockets may be too much rounded in finishing.

Fig. 235. Tube teeth with cone-shaped base.

In the case of the grinding teeth, it is an advantage to make them slightly cone-shaped (Fig. 235) as thereby there is less risk of undermining them — particularly on their lingual surface during the finishing process — than when their surfaces are parallel or nearly so. The vulcanite should always be carried up about a sixteenth of an inch from the base of the teeth on their lingual surface. This furnishes a socket, and permits of a better finish being obtained.

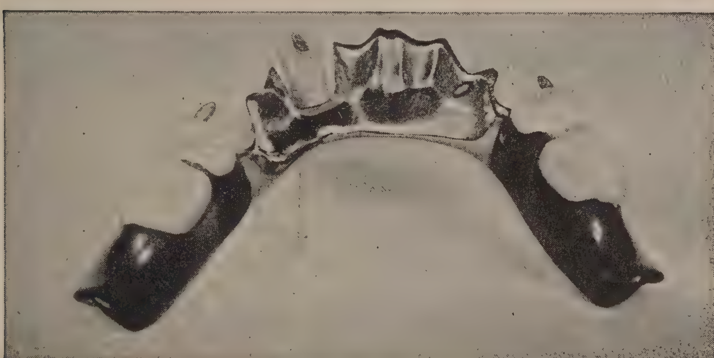
Another method is to coat the pins and interior of the tubes with plaster or whiting, and thus prevent the rubber from flowing into the tube, and after

vulcanizing — but before finally finishing the plate — remove the teeth, and afterward fix them on with cement.

Combination plates of gold or other metal wherein vulcanite is employed as a means of attaching the teeth to the plate, as well as vulcanite plates with gold or wire strengtheners, afford equal opportunities for employing tube teeth or gum tube teeth or sections, while in addition they permit of their use in certain cases whereby their peculiar advantages are made available: Fig. 236 shows a partial lower combination plate where plain teeth with vulcanite attachments have been used to supply the grinding teeth, while the missing lateral is supplied by a tube tooth. Here the advantage of the tube tooth is apparent for several reasons. Owing to the canine having moved backward, a space has been left between the canine and central, too small to permit of the use of two normal sized teeth, yet too large for one, without the risk of showing the metal backing or vulcanite attachment, and there is always the possibility of having to replace such a tooth owing to fracture, shortening of the tooth due to the sinking of the plate, etc. By employing a tube tooth we insure easy replacement, without the necessity of soldering or vulcanising, while at the same time there is the advantage to be derived from an all-porcelain tooth, and the peculiar advantages which result from the employment of the tube form. Where one or more tube teeth are used in the manner described, the attachment should be by means of cement or sulphur, but where the whole of the gold is covered with vulcanite, the attachment may be carried out by its means, although generally

speaking it is best to cement the teeth on to the pins after the case is vulcanised. Instead of pins depending upon vulcanite for their anchorage, they

A



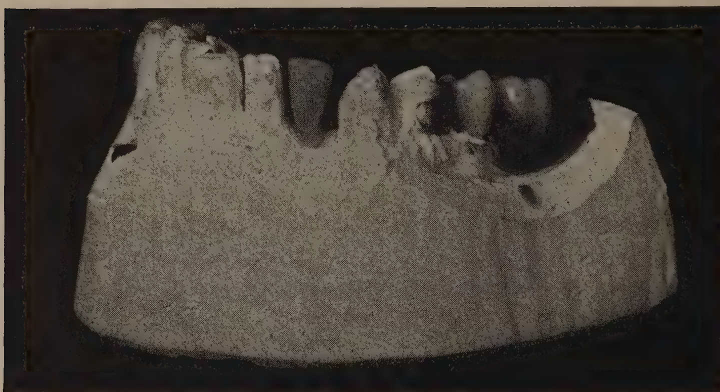
B

FIG. 236. Partial gold and vulcanite plate. A, On model. B, With isolated tube teeth.

may be soldered to the plate. This method necessitates the use of a face bite, in order to obtain the correct position of the pins, which may be of gold

or dental alloy. The pin should be roughened to afford a hold for the cementing medium also. Provision for attachment of the vulcanite to the gold may be by means of catches, roughening by means of a graver, etc.

When it is intended to remove the teeth after vulcanising, and set them with cement, the pins should not be roughened until after the plate has been finished. The removal of the teeth may be



c

Fig. 236.

easily effected by heating them slightly, when by means of a pair of forceps the blades of which are covered with lead in order to avoid the danger of damaging the teeth, they may be readily detached without danger of disturbing the pins, if reasonable care is exercised. In fact, the teeth can often be dislodged without heating if the precaution already spoken of has been taken, to coat the interior of the tube with plaster or whiting before vulcanising.

The application of single gum tube teeth or gum tube sections is carried out on the same lines as in

the case of single tube teeth, and the jointing of the various sections is done in the same manner as with ordinary gum sections. There is this difference, however, in connection with their preparation for the purpose of using them in connection with vulcanite only, or with a metal plate with vulcanite attachment, that ordinarily a certain amount must be ground away from the base of the lingual surface to permit of a sufficient amount of vulcanite underneath the teeth (Fig. 237), and for metal catches when a metal base or strengthener is employed.

A B C A B C

FIG. 237. Single-gum tube molar and central. A, Front view. B, Side view. C, Tooth cut away for vulcanite attachment.

Instead of the ordinary form of catches, some of the pins may be soldered, and these will serve to anchor the vulcanite to the plate, as already pointed out, or the pins may be of the ordinary headed variety, and these will serve to anchor the sections to the vulcanite. The amount of vulcanite need seldom be so great as in the case of ordinary gum sections.

In cases of accident, necessitating repair or renewal of one or more teeth or sections, this may be carried out without the necessity for vulcanising.

Replacement of a tube tooth or gum tube section is usually a much more simple matter than in the case of plain teeth or ordinary gum sections, for the reason that the tooth, or what remains of it, pro-

vided it has been fractured, may be easily removed, and a new tooth or section fitted and cemented to place.

In the event of the post being broken, a new post will require to be vulcanised in its place. It seems almost superfluous to remark that tube teeth and sections may be used along with all other forms of teeth or sections.

CHAPTER XVI

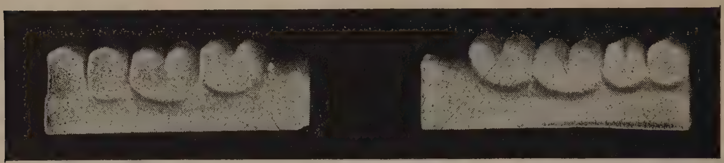
PORCELAIN SADDLE BRIDGES AND PARTIAL PLATES FORMED FROM PORCELAIN RODS

As the line of demarcation between removable bridges and partial plates is much less marked than formerly, and as the technique of the various stages in shaping and fitting porcelain blocks to form these is the same, the description which is given below applies to both, and it is considered that it is better to follow this plan rather than divide the fitting of porcelain blocks in this way between the subjects of bridge and plate work.

When one considers the reluctance which has hitherto been shown to do more than the minimum amount of grinding of porcelain teeth or crowns, it is not surprising that the idea of employing a mass or block of manufactured porcelain for the purpose of shaping up, by grinding, porcelain plates, or saddle bridges with teeth in one piece, has not hitherto been suggested. Doubtless the idea has occurred to many and been discarded on account of the supposed amount of time and labour which it would involve, its difficulty, and the supposed improbability of obtaining satisfactory results.

With regard to the amount of time and labour, these have been fully considered in the chapters on grinding and shaping where it has been seen that the improvement in the grinding materials and

appliances now available, and the further improvement which may be reasonably counted upon in connection with grinding wheels, has largely discounted these factors. Figs. 238 and 239 afford additional proof that the amount of time necessary



A B

FIG. 238. A and B, Shows buccal and lingual view of a section of tube rod roughly shaped up to form partial lower porcelain plate. Time taken, 30 min.

to remove a substantial amount of porcelain by grinding is not a serious factor in the total time spent in forming a plate or bridge, as the time taken up in doing so is spent mainly in considering where to grind. At the same time the question of the amount of time required to shape up and fit a partial porcelain plate, and the comparison this would bear to the time required for making and finishing a similar

A B

FIG. 239. A and B, Shows buccal and lingual view of a section of tube rod roughly shaped up to form partial lower porcelain plate and fitted to alveolar ridge. Time taken, 1½ hrs.

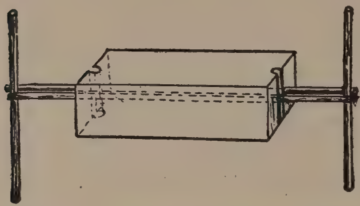
partial gold plate with teeth complete, will naturally occur to many. No definite answer can be given to this, but practical experience has proved that even with a limited amount of practice, and with no more than average skill, the time taken will

range from 45–90 minutes for each tooth on the porcelain plate, and in most cases the latter time will prove ample for completing the smoothing and polishing of the porcelain plate and teeth, but it is not meant to include the time spent in making the bands and soldering them to the horizontal bars, but only for the porcelain plate and teeth alone. These, however, would not occupy much time, and it is to be remembered that there is no time spent in taking dies and counter-dies for striking up a plate, there is no slow heating up and cooling down of the plate and teeth for soldering, and no slow heating up of investment as when a cast plate is used.

There, remains then, the apparent difficulty and the seeming improbability of obtaining a satisfactory fit. With regard to these, the difficulties are much more apparent than real, and the reader may feel assured that any fears he may have on this score are groundless. Practical experience has not only proved this, but that it is as easy to fit a porcelain block accurately to a model of the alveolar border as it is to fit a crown to a root or to a metal plate. Before showing how this can be done, it seems desirable to point out some of the advantages which porcelain possesses over other materials, and these may be borrowed from the claims which are advanced in favour of continuous gum work over other materials, with the further advantage in favour of pieces shaped up from manufactured porcelain of greater strength, the absence of a metal foundation and framework, the possibility of obtaining a more natural appearance, a lighter piece, provision for attachments by means of horizontal or vertical posts or bars, diminished liability to fracture or chipping,

and more perfect compatibility of porcelain to the gum tissue than is obtainable by any other material.

The tube rods and blocks which have so far been designed, limit the application of this method to partial cases only, nor is it ever likely that a full upper or lower case shaped up from a single porcelain block would prove a practical success by this method. At the same time, a full lower could be successfully made in this way by joining together the required sections by means of inlays formed on the ends of the bars of contiguous blocks, and the same might be done with the upper if a metal or other palate was employed. Possibly these porcelain rods do not yield sufficient material from which to form certain partial plates or even saddle bridges, but this deficiency will doubtless soon be remedied. A description of the case shown in Fig. 241, which is that of a partial lower to supply the whole of the grinding teeth, will probably best describe the steps in the process. A good model and bite having been obtained, the model should be thoroughly dried, and afterwards boiled in stearine or a mixture of bees' wax and rosin equal parts, for about 10 minutes, in order to harden it so that it may not



A

FIG. 240. A, Shows porcelain block with groove at either end; bars horizontal joined together with vertical tubes.

B

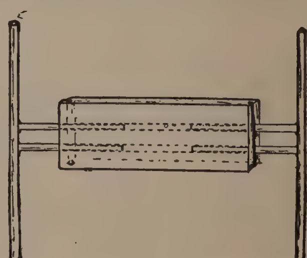


FIG. 240. B, Shows porcelain block with grooves. Bars vertical.

be accidentally bruised in the process of fitting or permanently marked or disfigured by the vermilion paint used in ascertaining the points of contact on the porcelain block during the process of fitting. Provision must now be made for vertical tubes and posts to form guides for ensuring the return of the porcelain block to its exact place on the model, while the base of the block is being fitted to it. By means of a twist drill, therefore, a hole should be drilled through the plaster model close to the canine and enlarged on its under or hidden surface. Through the hole a perfectly straight length of German silver or steel wire, size $13\frac{1}{2}$, U. S. G. should be passed, sufficiently long to note that it is vertical to the alveolar border. A bend having been made on the lower end of the wire, it should then be securely fixed in the recess made in the base of the plaster model either by means of plaster, modelling compound, or dental lac. By means of a copper or brass disc, a groove of the exact size to fit the post should now be cut vertically on the end of the porcelain block next to the canine, and another similar vertical and parallel groove should be cut in the opposite end, the block being left a little longer than it is meant to be when finished. The block is next held in place on the model, care being taken to note that the porcelain is close up against the plaster tooth, when the position for the posterior post should be marked on the model and a hole

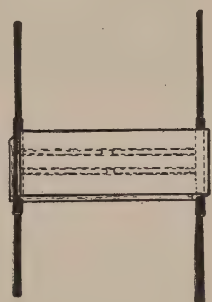
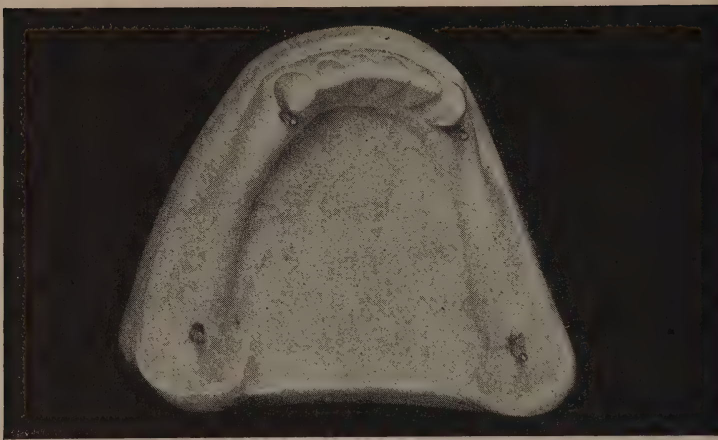
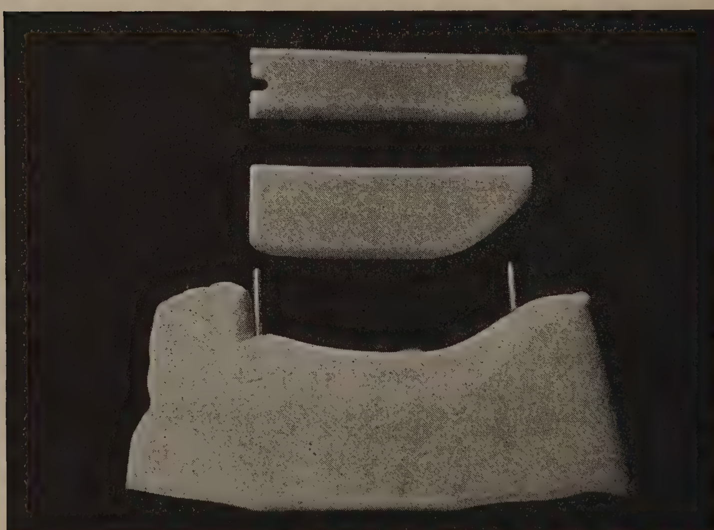


FIG. 240. c, Shows porcelain block with bars and tubes with posts in position.



A

FIG. 241. A, Shows lower model with vertical posts to act as guides in fitting porcelain block.



B

FIG. 241. B, 1. Shows side view of lower model with vertical parallel posts to act as guides in fitting porcelain block. 2. Porcelain block partially fitted. 3. Upper surface of porcelain block with guide grooves formed in the ends.

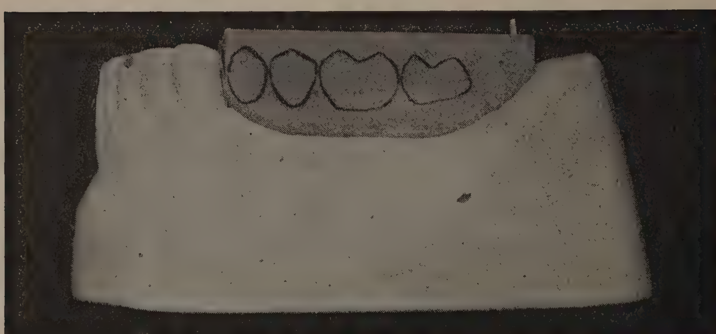
drilled through it and countersunk or enlarged on its under side, and a post passed through the hole in the model and fixed in the manner already described, great care being observed to note that the posts are exactly parallel. If they are sufficiently long to begin with, this can readily be seen, and they can be shortened after they have been securely fixed. During the process of securing the second post the porcelain block should be held firmly in place in order to act as a guide. The conditions are now similar to those which exist in fitting a double tube rod when vertical posts are employed. While the foregoing method of obtaining guides suits admirably, there are other means of doing so, one of which is by means of temporary bars and tubes, as in Fig. 240, which shows two lengths of thin vertical tubes soldered to short horizontal bars which enter the tube in the porcelain block. The tubing may be $13\frac{1}{2}$ U. S. G., or less, but it must necessarily be of the proper size to suit the temporary posts. A few of those temporary tube and post guides may be kept on hand and used over again for other cases, or a pair of them may be made in a few minutes.

Having obtained suitable guides in the manner described, the rough fitting of the block to the alveolar ridge may be carried out by means of large and coarse grit wheels. Gradually, as the fitting proceeds, smaller and finer wheels should be used and vermilion paint used to mark where the porcelain must be ground off. After the fitting of the blocks has been completed, the position and size of the teeth to be formed should be outlined on the blocks (Fig. 241D) and the shaping up should be proceeded

with. When this has been fairly well advanced the bite should receive attention before the final

C

FIG. 241. C, Shows blocks fitted to model.



D

FIG. 241. D, Shows side view of block fitted to model and shape of teeth outlined.

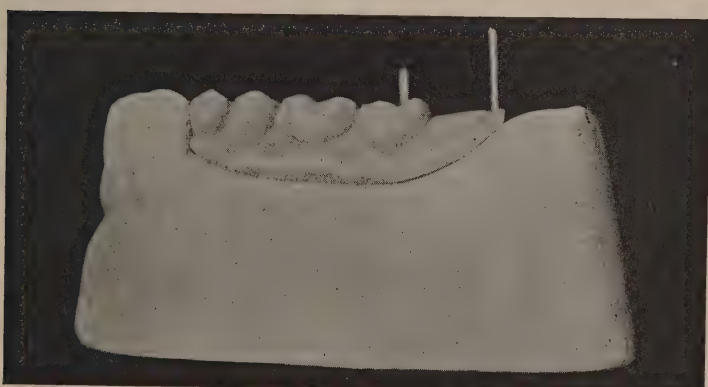
shaping up is done, after which the porcelain should be smoothed and polished.

The blocks having been finished, a recess should be ground in the anterior approximal side of the

first bicuspid of each block and extended on to the lingual surface, for the purpose of containing an

E

FIG. 241. E, Shows finished plate.



F

FIG. 241. F, Shows side view of plate.

inlay joining the horizontal bars together. A plate should be struck or cast to fit the gum behind the

natural teeth in the ordinary way, or a bar may be used for a like purpose. If the inlay connecting the two horizontal bars which passes through the tubes is not to be carried to the grinding surface of the

G

FIG. 241. G, Shows horizontal bars partially withdrawn from porcelain sections showing inlay and plate attached.

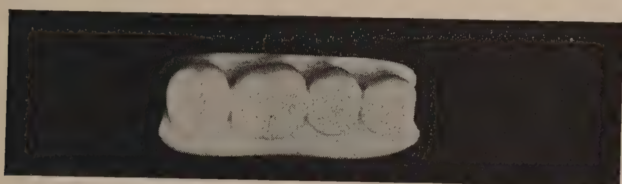
H (i)

FIG. 241. H, (i) Shows a partial upper porcelain plate for the right side of the mouth, consisting of two molars and a second bicuspid shaped up from tube rod No. 26.

first bicuspids, then the anterior post must be brought forward by the thickness of the post, and this will necessitate trimming from the posterior surface of the canine tooth on the model, a sufficient amount to enable the porcelain to be close up to the

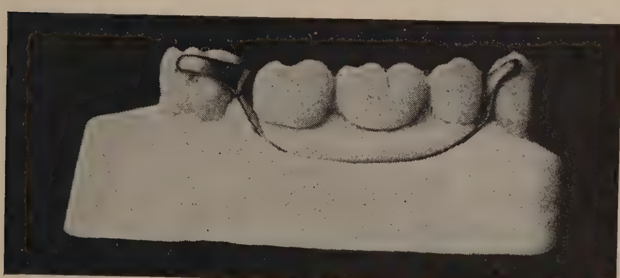
H (ii)

FIG. 241. H, (ii) Shows clasps attached to inlays formed on the rods of the horizontal bars which are partially withdrawn.



I

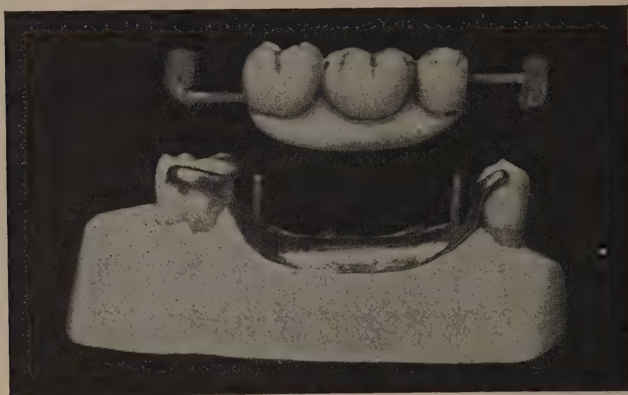
FIG. 241. I, Shows another example of a partial upper porcelain plate formed from rod No. 29.



K (i)

FIG. 241. K, (i) Shows a partial plate for the right side of the lower jaw cast in gold. The three teeth and porcelain body are shaped up from rod No. 26. Anchorage of block to metal base is obtained by means of tubed inlays formed on the end of the horizontal bars and the posts attached to the cast metal base complete the anchorage.

canine in the finished piece. Fig. 241 helps to show the various steps in the construction of the partial lower porcelain plate spoken of.



K (ii)

FIG. 241. K, (ii) Another view showing cast plate with vertical posts, also porcelain block with horizontal bars partially withdrawn, to the end of which the tubed inlays are attached.

The Fitting of a Porcelain Saddle Bridge

Where anchorage is not provided by means of posts on capped roots, the fitting should be carried out in the manner described, and the subsequent steps carried out on the lines shown in connection with other bridges, of which examples are seen in Figs. 203 and 211. Where the porcelain teeth require to be stained and gum enamel added, this should be done before the metal parts are completed.

Duplicate Models

Where a large surface such as a plate is to be ground to fit, it is sometimes advisable to do the fitting on a separate model, and retain the original one either for final fine-fitting or for reference, and

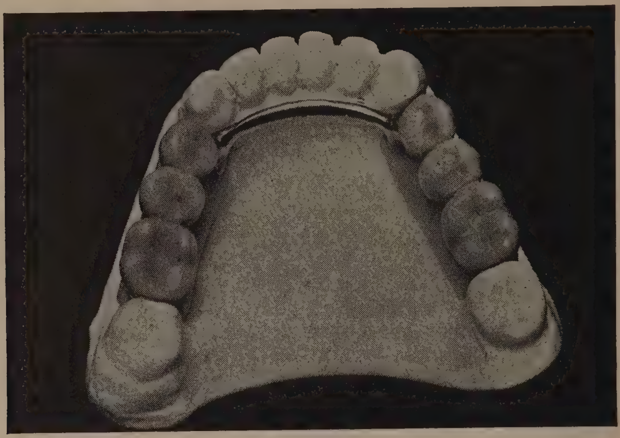
a duplicate model for this purpose, or in point of fact any number of duplicates, can be quickly and easily formed.

Over the posts on the original model, are placed metal tubes to fit the posts easily but accurately, the tubes being roughened or having tags soldered to them to engage or secure them in the impression of the model, which should now be taken, in one of the many well-known ways whereby models are duplicated. The impression having been taken, posts to fit the tubes are now inserted into them, the projecting ends being left sufficiently long and being at the same time bent or roughened in order to hold them securely. The impression is then cast in the usual way, and when parted the model gives an exact duplicate of the original with the post in place. Instead of casting the impression in plaster, it may be cast in fusible metal or partly in metal and partly in plaster. If altogether in plaster, the model may be dried and hardened in any of the usual ways. The subsequent steps are as already mentioned.

Lingual Bars

To those who favour the use of a lingual bar in cases similar to that shown in Figs. 242 and 243, the following plan whereby such a bar may be quickly made and accurately fitted, will probably commend itself. Fit two round wires about size 15 U. S. G. to the gum, leaving them a trifle longer than is required, in order to permit of their being anchored into investment. Wax the wires together either with ordinary wax or sticky wax, leaving a small excess of wax on the surface next to the model:

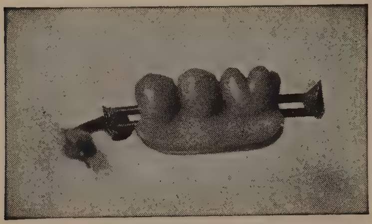
slightly oil the model on the surface where the bar is to fit, and while the wax is still soft, place



A

FIG. 242. A, Shows partial bar lower porcelain plate with blocks of three teeth shaped up from rod No. 26 in the method described.

the united wires with wax on the model and press in to place, moulding the wax with the fingers, so that it takes an impression of the model. Carefully remove the wires and wax and invest, and flow up with gold plate or solder. By tilting the investment to either side, and directing the heat as required, the solder may be made to flow so that the vacancy formed by the wax will be filled up, and also the space between the two wires. Little if any filing up is afterwards required.



B

FIG. 242. B. Shows buccal view of left block with the horizontal bars partially withdrawn with inlays formed on the ends. The anterior one is soldered to the lingual bar: the posterior inlay is shown without attachments but can be utilised as in Fig. 243.

A

FIG. 243. A, Shows partial bar lower porcelain plate with blocks of two teeth shaped up from rod No. 26.

B

FIG. 243. B, Shows buccal view showing clasp attached to posterior inlay which is joined to horizontal bars.

CHAPTER XVII

SETTING CROWNS AND BRIDGES, AND CEMENTING TUBE TEETH TO PLATES

THE methods employed in attaching tube teeth, bridges, or gum tube sections to the various bases and anchorages which have been spoken of, are similar to those followed in connection with the usual forms of crown and bridge work.

With regard to the various media, those most frequently used are cement, gutta-percha, gutta-percha cement, sulphur, amalgam, vulcanite, and screws. Before proceeding to consider these, however, attention is directed to the fact that with tube crowns the attachment — generally a cap and post — can always be fixed on to the root before the crown is cemented to place; also in tube bridge work, the attachments being formed independently of the body of the bridge, can often be permanently fixed to the roots before the body of the bridge is finally set. This has a more important bearing upon the choice of the cementing medium than at first appears, and favours the use of gutta-percha rather than cement in a larger number of cases than where most other forms of construction are employed. The materials and methods employed for the purpose will depend upon various factors, such as the nature and extent of the anchorage available, and the

personal inclination or preference of the operator. The cementing media most commonly used are cement and gutta-percha, either singly or in combination.

Cement. Cement has the advantage of affording the maximum amount of adhesion, and so is of special value when a doubt exists with regard to the fixity obtainable by other means. It is, however, open to several objections among which are its solubility, porosity, and difficulty of removal in case of accident or necessity. Its rate of solubility may be lessened by attention to careful fitting, so that the junction between the root and the cap or crown is made as close as possible, as thereby the cement will obtain the maximum amount of protection. Its porosity permits it to become infected by putrefactive bacteria. This, however, can be prevented by the addition of about a tenth part by bulk of hydronaphthol to the cement powder, to which also may be added a drop of oil of cinnamon or cloves.

Gutta-percha. The advantages possessed by gutta-percha when skilfully used are the ease with which it can be removed, its insolubility, non-irritating properties, and tendency to reduce shock or stress on the abutments. The objection usually urged against it is the difficulty of manipulating it and the time thereby required to obtain the best results. The gutta-percha which is best suited for the purpose is the ordinary base-plate variety, but care should be taken to avoid using too much gutta-percha, as this involves danger of spreading the band.

Gutta-percha and Cement. The best results are usually obtained, however, by the use of a combination of cement and gutta-percha, as these permit of

the crown or bridge being more easily removed if necessity arises for doing so. They should be employed in the following manner: — The post being roughened by spurring it with a knife, in order to help the gutta-percha to adhere, post and gutta-percha should be heated, and a small quantity of the latter, barely sufficient for the purpose, moulded along the post, when cap and post should be tried on to the root, forced carefully to place, and any surplus removed or the interior of the cap and post may be coated with chloro-gutta-percha. The final cementing is then to be carried out in the usual way, and the details of this process need not be entered into, as these are familiar to all. But before cementing a crown or bridge to place, all of the surfaces of the natural teeth which have been ground should be treated with a saturated solution of nitrate of silver.

Setting a Bridge with Cement at one end and Gutta-percha at the Other

It is sometimes desirable to take advantage of the properties possessed by cement and gutta-percha in the above manner, and the cases in which a combination of these fulfills the desired results are fairly numerous. For example, the anchorage at one end may be ample, while at the other it may be deficient for the purpose of attachment by means of gutta-percha. In such a case the following plan will be found to yield entirely satisfactory results: The usual steps are carried out with regard to the preparation of the anchorage for cement and gutta-percha, and the latter is carried to the point where final softening only is required before forcing the bridge to

place. While an assistant mixes the cement, the operator should get ready the bridge for setting, and as it will have been heated throughout its whole length, the following plan should be adopted, whereby the end to be cemented is made cold, and will remain so long enough to permit the piece to be accurately forced to place, while the other end is not chilled too quickly. A stream of ethylchloride spray should be directed on to the end of the bridge which is to be cemented and almost up to the middle of it. The cementing may then be carried out quickly in the usual way, before the cement has been affected by the heat, or the gutta-percha by the cold.

The material and methods employed for attaching horizontal bars or posts into the tube of a crown or bridge afford considerable choice. As previously pointed out, the unglazed interior of the porcelain tube and roughened surface of the posts, along with a thin layer of oxyphosphate cement, provide an enormously strong attachment, stronger, indeed, than is necessary. Unless there is a liability of the abutments spreading, the cementing medium need do little more than exclude moisture, consequently very soft gutta-percha, or one of the gutta-percha cements may be used. These are always to be relied upon; but no hard-and-fast rule can be laid down for all cases. A description of the methods employed in connection with the use of gutta-percha cements, Onilite and Evans' Gutta-percha Cements, need not be given here. These are fully set forth in the instructions which accompany them.

Amalgam, screws, and other devices may be employed with advantage in the manner ordinarily described in connection with their use, and the

facilities afforded for doing so are probably greater in the case of tube work than in any other.

Method of allaying pain after setting Crowns or Bridges

However carefully the method of cementing has been carried out, the bands fitted to the roots, and their depths proportioned to the case, the cementing on process is nearly always painful — slightly so, no doubt, in some cases, moderately so in most. In these cases pain is doubtless due to a hyperæsthetic condition of the periosteum and gum. From whatever cause it may arise, it is a form of pain which some patients are peculiarly intolerant of, and for that reason alone it is desirable to get rid of it as quickly as possible. It is surprising to find how ineffectual cocain is under these circumstances when applied between the gum margin and the neck of the tooth. Of course, a few drops injected will give complete anæsthesia, but this is objectionable on several grounds, and is wholly unnecessary. The following plan will be found to give almost instant relief, and is unfailing in its action: Fill a fairly large — say a 2 oz. — syringe with very hot water, as hot as can be borne without producing actual pain on the gum. The right degree of heat can be approximately judged by directing a stream on the finger before applying it. Before the cement has quite hardened, remove all pieces of lint, cotton, etc., from the mouth, and having the saliva ejector in place to remove the hot water as fast as it is applied, direct the stream of water forcibly on to the gum around the neck of the tooth by holding the point

of the syringe about two inches away from the neck of the tooth. By the time the syringe is half empty, the pain will either have completely disappeared, or nearly so. All surplus cement should then be removed. Once more a *forcible* stream of hot water should be directed around the neck of the tooth, and between the band and the gum, and if need be a third one, but this is rarely, if ever, called for. It is noted, therefore, that we have in water, used either hot or cold as the circumstances of the case may demand, a simple, powerful, and easily controlled anæsthetic agent (See Chap. V.) which is always at our command, and which is entirely free from the objectionable features which sometimes accompany the use of other anæsthetics. Doubtless when the powerful anæsthetic properties of hot water are fully realised, it will obtain wider recognition. When gutta-percha is used as the cementing medium, the same plan should be followed.

Sulphur. The use of sulphur as a cementing medium dates back to the eighteenth century. It is most commonly employed for fixing tube teeth to gold plates, and where it is possible to do so it is to be preferred to cement, for the reason that if circumstances arise which necessitate the removal of the teeth from the plate, this can be easily and quickly done by carefully heating the case to the melting point of sulphur.

Sulphur can, of course, be employed in crown and bridge work also, but its special advantages are most apparent in plate work. The method of using it is as follows: — The plate having been finished in the usual manner, a few shallow cuts are made in each pin with a file. The teeth having been cleaned and

freed from all traces of oil — which can be done by boiling them for a few minutes in a strong solution of soda — the tubes should be dried by means of cotton wound round a broach, and, where platinum tube teeth are used, their interiors roughened by a clean tube file. The sulphur is melted in a small porcelain cup or an iron spoon until it is quite fluid. The plate should be grasped with pliers held

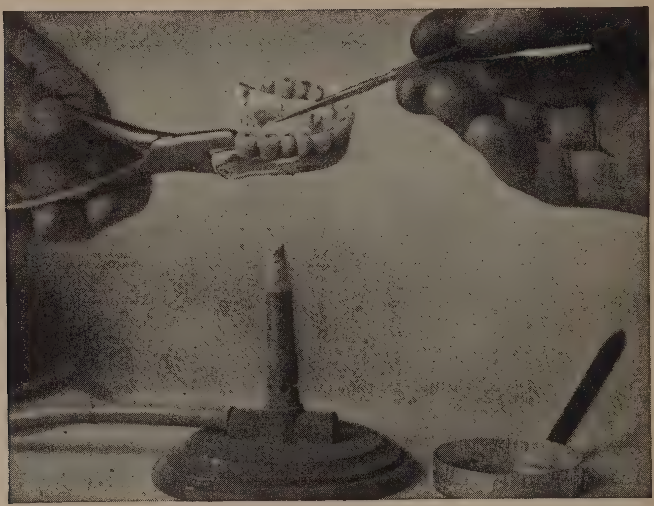


FIG. 244. Shows mode of grasping plate in finally fixing teeth.

in the left hand (Fig. 244), and plate and teeth heated carefully over a spirit or small Bunsen flame. This must be done gradually, and the flame ought not to be allowed to play on the porcelain for fear of cracking the teeth, while the temperature should never be allowed to rise too high, as this would deprive the sulphur of fluidity. A wire spatula — a piece of flattened iron wire, pin-wire size — is dipped into the melted sulphur, and repeatedly conveyed to the heated plate and teeth. The sulphur runs

by capillary attraction under the teeth and along the pins. When it has been ascertained that the sulphur has filled all the tubes and spaces, and while it is still fluid, the plate should be removed from the flame and the teeth held firmly in place for a few moments until the sulphur sets, and in order to do so a few folds of linen rag should be used to grasp them with. Plate and teeth may now be allowed to cool, and the excess of sulphur removed by means of a fine-pointed knife or point, after which the plate may receive the final polishing.

Various modifications in the manner of using sulphur are employed; for example, rock sulphur broken into small pieces may be placed on the end of each tube, and when plate and teeth are heated the sulphur will run through, additional pieces being used until a surplus shows. Repeated melting of sulphur seems to improve its quality rather than spoil it.

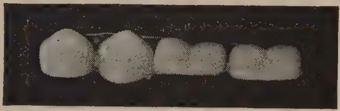


FIG. 245. Old type of shallow bite tube teeth.

Fig. 245 shows a buccal view of four tube teeth which are much thinner in the centre, and on their lingual surface, and the tube is not more than $2\frac{1}{2}$ mm. long. These afford evidence of the reliability of sulphur as a cementing medium. This old type of tooth was frequently used in cases of short bite, and with entirely satisfactory results, but care was always taken to insure that the teeth were accurately fitted to the plate. Doubtless the platinum tube lining afforded a slightly better hold than the non-platinum tube.

Where either a vertical or horizontal tube is not

required, it can readily be filled by means of a section of post cemented into it, and here it may be well to state how this may be done in the case of a bridge formed from a straight porcelain rod with single or double tubes, and the method is applicable in a similar manner to curved blocks also. Where the continuity of the tube is not broken by intersecting vertical tubes, the horizontal post or bar may be cemented to place, but where vertical posts entirely obstruct the passage of the horizontal one, a section of post or bar should be cut off equal to the length of the tube between the points A and B (Fig. 246) and cemented to place.

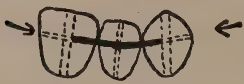


FIG. 246. Shows how each short length of wire is cemented in from either end.

CHAPTER XVIII

A SUGGESTED REVIVAL OF GUM TUBE TEETH AND SECTIONS

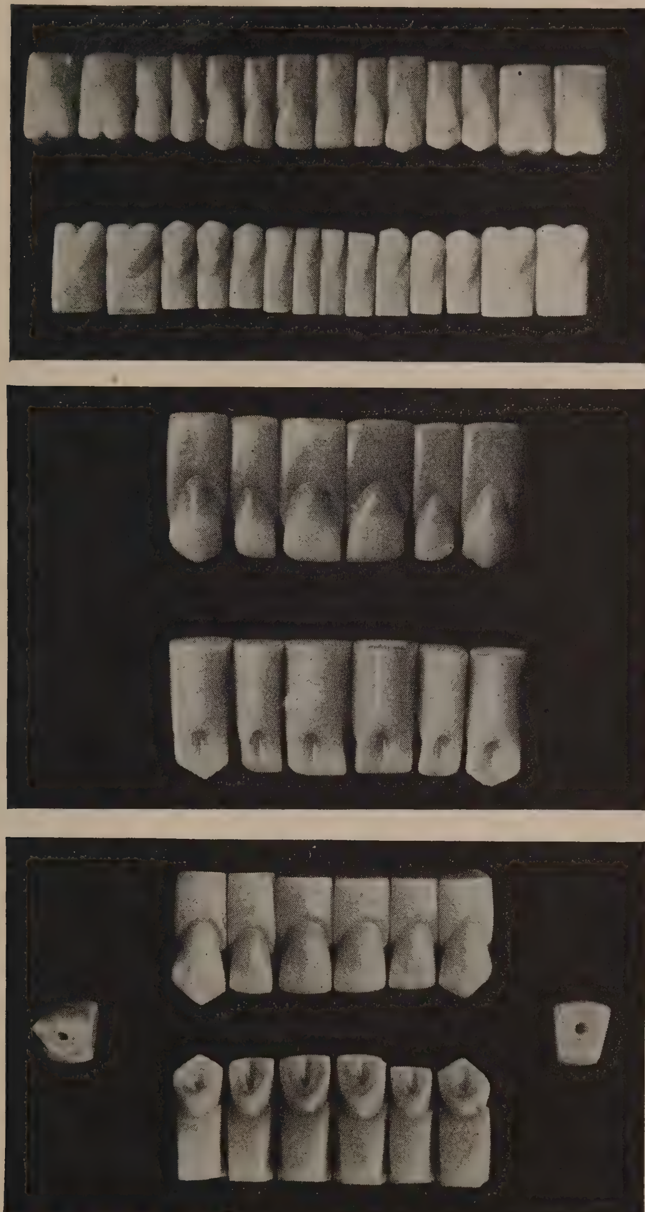
IN bringing forward suggestions regarding a revival in the manufacture and use of tube teeth and crowns, only a passing reference was made to gum tube teeth and sections. These have been far too long neglected, so long indeed that they are only known in collections of old prosthetic pieces, though their modern, but far less adaptable representatives gain favour at the expense of the old pattern tube variety. Some of the causes which have resulted in the neglect of those old forms of gum tube teeth and sections are similar to those which adversely affected the use of tube teeth and crowns, but there are others which it is needless to attempt to enter into fully.

As early as 1837, various forms of gum tube teeth were manufactured on a commercial basis in England, their tubes being lined with gold. About 1845 various forms of gum tube sections were introduced these also having gold tubes. In 1856 platinum tubes were substituted for the gold ones, and these gum tube teeth and sections were largely used prior to the introduction of vulcanite about 1858, and were then employed with decreasing frequency, while for many years their use had been entirely discontinued.

There is no evidence to show that gum tube teeth

and sections were ever manufactured in America on a commercial basis, but about 1856 both gum teeth and sections — for use in connection with the Blandy process — were manufactured by the S. S. White Co., and by Messrs Ash & Sons, and Lemale & Co., and were soon followed by gum teeth and sections with platinum pins for use in connection with a vulcanite base, and these latter have been largely used up to the present time. Those for use in plate work were doubtless introduced at an earlier date; at all events they were manufactured in England before 1850. It is surprising that the single gum pin teeth and sections for use in vulcanite work should have succeeded in displacing the pinless forms, as they are in no way superior; and it is not surprising that pinless forms of teeth should now be displacing those with platinum pins, although the latter are inferior to their prototype, the original pinless form.

Had it been realised at the time when gum teeth and sections with platinum pins for use in vulcanite were introduced — about 1858 — that platinum would ever reach its present price, and that pinless forms would prove as adaptable in every way, it is safe to affirm that these gum teeth and sections with platinum pins would never have been introduced. An even greater mistake, however, was made in failing to recognise the superiority of gum tube teeth and sections for use in vulcanite, as well as plate work. Doubtless this arose from failure to recognise the possibility of employing them in this way, while the obstacle presented by the lack of suitable appliances for grinding was an additional drawback.



A

B

C

FIG. 247. Some old forms of single tube teeth.

Attention will now be directed to the advantages which would be derived by the adoption of gum tube teeth and sections in place of the forms of platinum pin and pinless teeth at present in use. The outstanding point with regard to the superiority of the former is their suitability for use in connection with the casting process. In this respect they hold a unique place, as none of the other forms are adapted for use in this way; but, in addition to this, they are also suitable for use in all cases where other forms of gum teeth are employed, yielding better results in most, while under no circumstances are they inferior. The claims advanced in favour of tube teeth are applicable also in connection with those sections, and at the risk of being accused of too frequent reiteration, a few of them may be repeated.

Their adaptability has already been spoken of in conjunction with the casting process, and will be described later on, as will also the use of tube teeth and single gum tube teeth in this way. Figs. 247 and 248 will show a few of these old forms of single gum tube teeth and sections. The advantages spoken of were strength, easiness of repair, security of anchorage, natural appearance, and comfort.

Strength. With regard to strength, this is apparent from the bulk of porcelain, which is disposed to greatest advantage for this purpose.

Easiness of Repair. In the event of fracture, or from any other cause which may necessitate replacement, a new tooth or block can be substituted much more quickly than by either vulcanising or soldering. In consequence, the risks associated with these methods are eliminated.

Anchorage. The subject of anchorage is one of

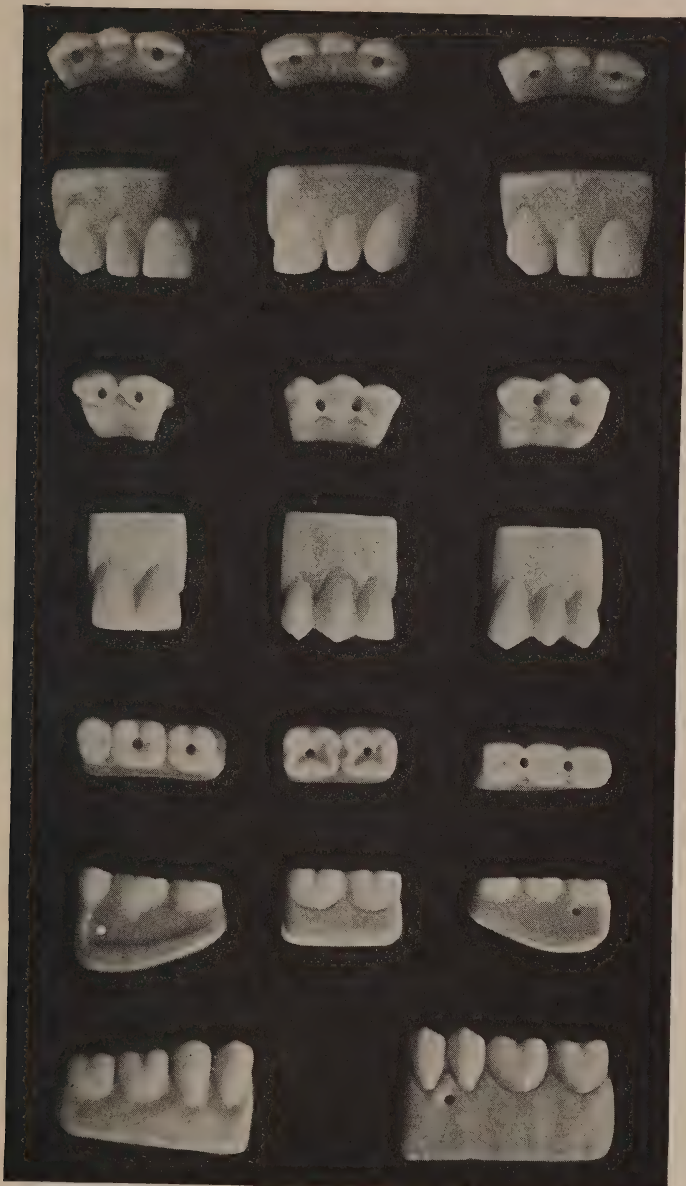


FIG. 248. Old forms of gum tube teeth and sections. Note the provision of swivel bolt for spiral springs in some of the bicuspid and molar sections.

great importance, and it will be observed that ample provision is made for this in connection with gum tube teeth and sections, when either the old method of grinding and fitting or the casting process is employed, while the same applies to their use in vulcanite work. But it may be worth while to point out once more that gum tube teeth and sections permit of greater adaptability in cases of abnormal overbite than do pin gum teeth and sections, in dealing with which attempts to obtain additional overbite are made at the expense of the anchorage (Fig. 249).

Fig. 249. Showing the amount of overbite to be obtained even without grinding.

The bridge worker will at once realise the possibility in connection with these teeth and sections, the use of which would fill a gap at present imperfectly occupied by fused gum body. The provision for anchorage, however, as will be seen from the illustrations, is confined to vertical tubes, and while these afford ample anchorage for fixed and removable saddle bridges, an additional horizontal tube would be an advantage in some cases (Fig. 250). This might be introduced without interfering with their employment in other ways.

Other advantages which would result from the use of these teeth are derived from the smooth wall of porcelain on the lingual surface, and the increased amount of room which is available for the tongue resulting from the disposition and nature of the anchorage.

The application of these sections in plate work is similar to that described in connection with single

tube teeth, or two or more teeth shaped up from porcelain rods; one of the objections which resulted in the displacement of tube teeth by the platinum pin variety was the time spent in grinding and fitting; but this objection no longer holds good, because of improved methods and appliances. If these teeth and sections were now available, they would doubtless be extensively used because of

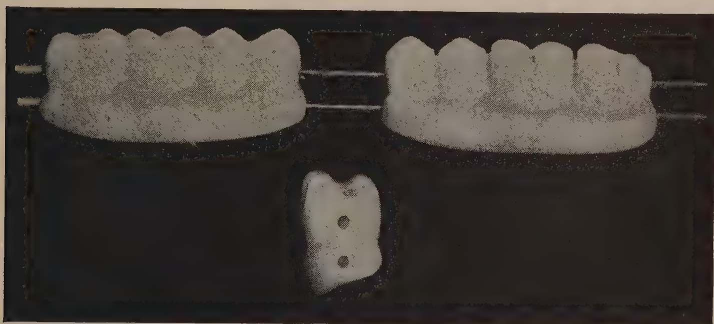


FIG. 250. Gum section blocks shaped-up from rod No. 28. Time for shaping-up, about four and a half hours — not including time for fusing gum enamel.

their suitability for use in the various classes of work spoken of.

It is, however, in connection with the casting process in plate work that the writer sees the greatest scope for their use, and the reasons for this, apart from those already given, may well be borrowed from the claims advanced in favour of continuous gum work. These are chiefly greater artistic freedom and hygiene. With reference to the former, it is true that greater scope is provided for obtaining any desired position for individual teeth than is possible with manufactured sections, but the bulk of porcelain and the ease with which it can be shaped up and afterward polished, render tube sections far

superior to the ordinary kind, while admittedly inferior to continuous gum work. On hygienic grounds the claims advanced are as sound for tube sections as for continuous-gum work or any other forms of teeth.

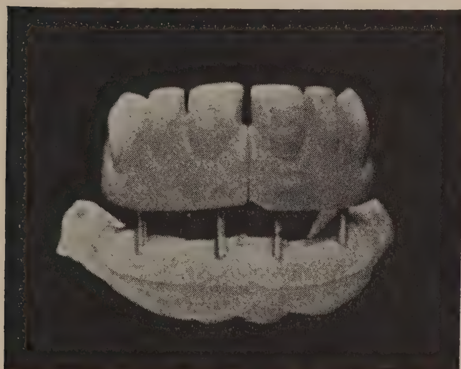
It appears, then, that the possibility of adjusting individual teeth is the only point where continuous-gum work obtains an advantage over tube sections, while the corresponding advantage which they possess over all other forms will be apparent.

The use of Tube Teeth, Gum Tube Teeth and Sections in connection with the Casting Process

After the model and bite have been obtained, the necessary steps with regard to the employment of gum tube teeth and sections in connection with cast plates are as follows: — A wax base-plate is made in the ordinary way, and the base of the tube teeth or gum sections should be rough fitted to the model, and their sharp edges neatly rounded off — they should also be fitted to suit the bite, and the joints accurately adapted. The tubes are next to be hollowed out a little at their bases, in order to permit of an extra thickness of gold for the purpose of increasing the anchorage of the pins. The teeth should now be slightly oiled, in order to prevent them from sticking to the wax, when they should be gently pressed into it, and any deficiencies with regard to fit made good by careful waxing up. The pins may be of dental alloy or gold, the latter for choice, as it gives a stronger union. The pins are next to be warmed, and all in turn placed in their respective tubes and pressed through the wax until they touch the model. The sections and wax having been chilled

A

FIG. 251. A, Cast metal plate with gum sections.



B

FIG. 251. B, Sections raised to show attachments.

C

FIG. 251. C, Lingual view.

with water, they should be removed carefully, so as not to alter the position of the pins; any superfluous wax may now be removed, the teeth or sections once more tried, in order to make certain of their position, then removed, when the investment and casting should be carried out in the ordinary way. In order to add to the anchorage of the pins to the plate, a slight groove may be formed around the base of each, or a very slight amount of solder sweated

D

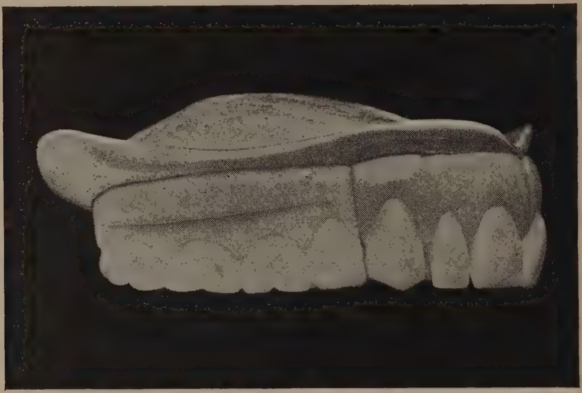


FIG. 251. D, Completed case.

on to the end. An alternative method is to indicate the position of the posts on the plate, and, after it is cast, solder the pins to the plate in the manner described in connection with soldering pins for tube teeth.

After the plate has been cast, and before proceeding to finish it, the teeth or sections should be stuck on temporarily with hard wax, in order to obtain the best finish and prevent damage to the pins during the finishing process.

From the foregoing, then, it will be seen that a case in which gum tube teeth or sections are used may

FIG. 252. Upper case with single gum front tube teeth, and molar and bicuspid sections.

A

FIG. 253. A, Shows lower case with cast metal base and single gum tube teeth.

B

FIG. 253. B, Teeth raised to show attachment.

be as easily and quickly made as a vulcanite plate, and the description given is applicable to tube teeth as well as gum tube teeth and sections.

The question of weight is not one which is likely to cause difficulty, as cast plates with tube teeth or gum sections need seldom be heavier than ordinary plate work, and far lighter than continuous gum work. There is also the choice of aluminium and certain alloys. Figs. 252 and 253 show various applications of single gum tube teeth and gum tube sections used in connection with the casting process. The writer is fortunate in possessing a number of the various forms of gum tube teeth and sections, most of which were made from 30 to 70 years ago, also some much older specimens.

Gum tube sections may be formed from tube rods as in Fig. 250, and the base of these only require to be roughly fitted when used with a cast base.

CHAPTER XIX

REMOVABLE FACINGS OR INTERCHANGEABLE TEETH

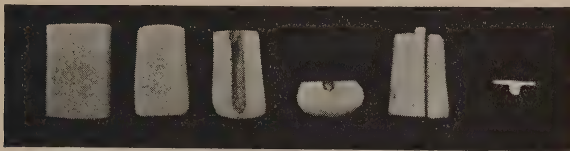
IN Chapter IV, page 45, it was pointed out that in certain cases of abnormally close bite, the whole of the porcelain covering the lingual surface of the post either of a tube crown or of a tube tooth attached to a plate, might be ground away and yet leave the porcelain facing as strong as, if not stronger than, an ordinary plain tooth unprotected by a backing; because in such a case the porcelain face would be supported in the whole of its length, provided the post was not ground too far through. Figs. 41 and 42 in Chapter IV illustrate the amount of anchorage which would thus be obtained in the case of a tube tooth or section of porcelain rod, as well as when a double tube rod or porcelain block is employed. It will also be observed that it is greater in the case of the former than the amount of anchorage provided by any of the well-known forms of removable facings, while in the case of the double-tubed rod used in like manner, the amount of anchorage obtained is greater than is afforded by any form of plain tooth, due to the fact that the anchorage tubes extend from the incisive edge, or, in the case of the back teeth, from the crown surface of the tooth or facing — to the cervical border. Moreover the disposition of the tubes, one on either side of the middle third of the tooth, adds greatly to its strength,

for the reason that a hold is obtained over the widest possible area. Thus, these facings may be employed for any or all of the purposes for which plain teeth, interchangeable teeth, or removable facings are employed. When used for vulcanite work, they require no anchorage post, although a simple form of anchorage, or anchorage and strengthener combined, can easily be formed. The tube tooth, when it has been ground away in the manner to be described, has more of the character of a natural tooth than any of the ordinary forms of plain teeth, for which it can be so readily substituted. Moreover, all the double-tube rods and porcelain blocks spoken of may be used to form two or more removable facings joined together in a manner similar to the illustrations already shown of tube crowns treated in this way, and the claims which have been advanced in favour of those multiple crowns where the tubes are used vertically are likewise applicable in the case of removable facings. In consequence, they permit of a much wider application of the principle than appears to have been hitherto suggested, while others will doubtless suggest themselves to the reader.

To form a Removable Facing from a Tube Tooth, Porcelain Rod, or Block

This is a very simple matter. In the case of one of the older forms of platinum tubed teeth the platinum tube or lining may be retained or removed. If for any special reason it is decided to remove it, this may be done by means of a cross-cut bur before the tooth is ground through to the tube on its lingual surface, or afterwards, when it may sometimes be

dislodged without much difficulty by means of a sharp instrument. The lingual surface should first be ground off by means of the large 4-inch wheel, $\frac{3}{8}$ inch or $\frac{1}{2}$ inch thick until the tube is nearly exposed.



A B C D E F

FIG. 254. Removable facing formed from single-tube rod. A, Section of the tube rod. B, Tooth roughly shaped up. C, Lingual view of facing. D, Incisive view. E, Backing. F, Edge view of backing.

It should then be ground quite flat by being held against the side of the same wheel, which should run perfectly true. But, previous to being ground, an accurately fitting post should be temporarily cemented by means of shellac into the tube or tubes to act as a guide to the amount which should be ground off, and at the same time to preserve the ground edges of the tube. Care should be observed

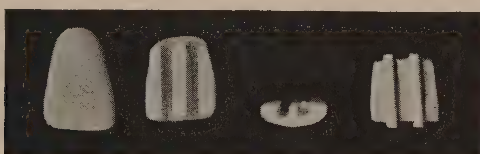


FIG. 255. Central incisor facing formed from double-tube rod No. 27, with backing.

merely to expose the platinum tube. If a doubt should exist about the lingual surface being perfectly flat, the tooth facing should be rubbed down or ground on a flat carborundum hone with water, using a rotatory motion. When a facing is formed

from a tube rod, a tooth or crown, it should be ground down nearly to the level of the tube, and the preparation of the lingual surface completed in the manner described. Fig. 254 shows the various stages. Fig. 255 shows a facing formed from a double-tube rod. When three facings are formed from a double-tube rod, the lingual surface of the section of porcelain should also be hollowed out (Fig. 256), otherwise the arc of the circle representing the labial surface of the teeth can only be obtained at the expense of needless thickness of the teeth, with its attendant disadvantages.

FIG. 256. A *a*, Labial and incisive views of section of block No. 33. B *b*, Shaped up. C *c*, Labial and incisive views of backing.

In grinding the concave surface of the block down to the tubes, a wheel 1, $1\frac{1}{2}$, or 2 inches diameter, and $\frac{3}{8}$ or $\frac{1}{2}$ inch broad, grit 80 to 100, should be employed, and a finer one, about grit 150 and of the same size, for final grinding. Great care should be observed not to carry the grinding too far; the point where it should cease is when the tubes are only just exposed evenly along their whole length, or it may be stopped short of this by about the thickness of notepaper, when the tubes may be further exposed in the whole of their length by means of a

thin S. S. W. vulcarbo disc, No. 3, 6, or 7. In the event of interchangeable teeth or removable facings, either single or multiple, being manufactured, the tubes might with advantage in many cases be size $15\frac{1}{2}$ U. S. G., therefore similar in size to the tube of the platinum tube tooth. This would permit of a thinner facing, an advantage which though seldom necessary, would not entail any sacrifice of strength which could not well be spared, and it would still leave these facings stronger than any others.

Fitting a Backing to a Tube Facing

In order to form a backing for a single-tube facing, take a piece of perfectly flat backing, and scrape it lightly in order to obtain a bright clean surface which will solder readily. Then take a length of straight wire which will accurately but easily fit the tube, and lightly scrape it also along the surface which is to be soldered to the backing. Now tie the wire and backing together by means of thin binding wire, and having boraxed the surfaces which are in accurate contact, apply a very small piece of solder to the joint and flow the solder carefully but thoroughly in the Bunsen flame. If this has been done carefully, the facing, after the backing has been pickled, should slip on easily. Success depends upon using the smallest possible amount of solder which will form a union of the parts and no trace of solder should be visible after the operation is completed. Where a double tube is employed, the procedure is similar, although the details are necessarily somewhat different. The first post may be soldered to the backing in the manner described;

the second post may have its relation to the first one (on the backing) determined by using a short length of tube rod cut from the same porcelain rod placed temporarily on the posts to act as a guide while soldering (Fig. 257). Instead of the sections of porcelain rod being employed as a guide, two small permanent guides made of brass may be used, one set for each of the double-tube rods. An alternative method is to solder both posts to the backing at the same time; or the backing and posts may be invested and then soldered, or a cast backing may be used, backing and posts being cast in one piece.

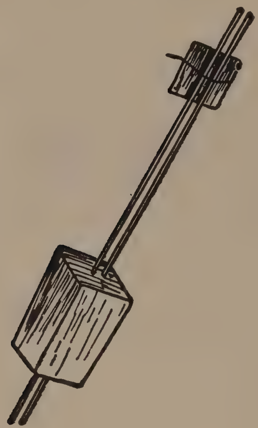


Fig. 257. Shows section of double-tube rod used as a guide for fixing position of wires to backing for soldering.

A Repair Facing

A repair facing may be formed in the manner shown in Fig. 258, and this may be done by cutting off a thin transverse section of a double-tube rod in the manner already described. Such a facing will often be found of use in replacing a molar or bicuspid facing broken off a crown or bridge, using the existing pins or anchor screws for the purpose of obtaining anchorage (Fig. 259). The position and

Fig. 258. Stages in the formation of a repair facing from double-tube rod No. 26.

size of the hole will allow of ready adjustment, and the facing may be cemented to place in the usual way, or a combination of cement and amalgam, or cement and porcelain cement, may be used. Should one or both pins come away with the porcelain facing of a molar or bicuspid crown, the remaining portion of the pins which may adhere to the backing should be ground off, and two holes drilled and tapped in the backing, and a headed screw screwed into each; or two short How screws used, and the facing cemented to place.

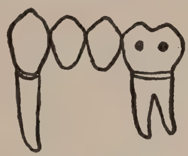


FIG. 259. Molar facing fixed with anchor screws.

CHAPTER XX

PAINTING AND ANNEALING PORCELAIN TEETH

THE introduction of porcelain enamels has made us much less dependent than formerly upon that wide selection of shades of teeth and crowns hitherto deemed indispensable, and the variations obtainable by their use cannot, in many cases, be got in any other way. It is unnecessary here to enter into a lengthy description of the use of these materials, as the instructions furnished by most of the well-known makers who supply them enable the least experienced to attain the end they have in view, with a little practice. The choice of high, medium, or low fusing enamel is, generally speaking, a matter of individual preference. The result of colouring teeth by the use of these enamels, or of glazing porcelain teeth or bridges by means of fusing a thin coating of transparent enamel instead of polishing them, makes the matter of cooling porcelain a question of importance; and while this has been already spoken of, its importance is such that no apology need be made for once more reverting to the subject, especially as most writers do not seem to have given this matter sufficient consideration. Doubtless this neglect has arisen from the fact that porcelain brought to a high temperature during soldering operations is protected by a mass of investment material, which, even when of moderate

bulk, permits of the porcelain being cooled nearly uniformly throughout; whereas when porcelain is brought to a high temperature without the protective aid of investment material such as the muffle of a furnace, a much longer time must be allowed for it to cool down uniformly if the maximum amount of strength is to be obtained.

The period between 1840 and 1880 may be said to have marked the highest level of porcelain tooth

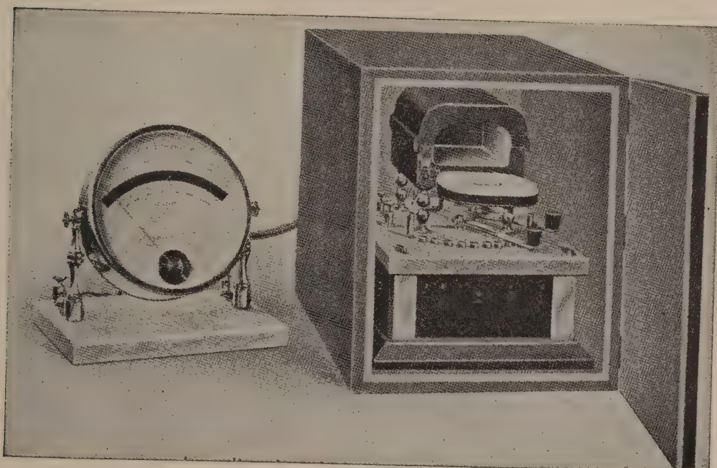


Fig. 260.

manufacture, but even until 1890 the quality was generally excellent, although there were distinct evidences of falling off. One of the reasons given for this in a former chapter was "the stress of modern competition." Formerly the muffle was allowed to cool slowly and evenly. This took from twenty-four hours to two or three days, the time depending upon the size of the furnace and muffle. Subsequent heating of such porcelain to a high temperature and allowing it to cool rapidly would not

greatly impair its strength or toughness, but such treatment would considerably weaken present-day porcelain which contains too little kaolin. In order that the maximum strength and toughness of the porcelain may be maintained, place the electric furnace in a box similar to that shown in Fig. 260. A box such as this should be made of wood or metal, but should be lined with asbestos slabs, about half an inch thick, carefully jointed so as to make it practically air-tight. After the porcelain has been fired, the door, which is also lined with asbestos in the same way, should be closed, and not opened for at least twelve hours. This will allow the porcelain to become sufficiently tempered or annealed, and so permit of its maximum strength being developed, although no treatment will improve an inferior quality of porcelain.

Tube Rods as a Foundation for Fused Porcelain Bridge Work

It has been pointed out that fused porcelain has proved a disappointing material in connection with bridgework, except in the hands of the most highly skilled workers. The reasons advanced in proof of this rest mainly on the lack of strength in the material, necessitating as it does a platinum framework strong enough in itself to permit of the strength of the fused porcelain being in most cases disregarded. Manufactured porcelain, on the other hand, is of sufficient strength, unless in cases of close bite, to allow of its use without the necessity for employing a metal framework, although in point of fact tube rods furnish the means of combining a framework and anchorage at the same time, and possess the ad-

vantages previously spoken of. There seems every reason, therefore, why tube rods should prove of great use in connection with fused porcelain work, furnishing as they do the necessary strength of porcelain body combined with a ready and efficient means of reinforcement by horizontal and other bars, which, as already described and illustrated, can be used for the purpose of assisting to furnish any of the methods of anchorage hitherto relied upon, and many others to which tube rods are specially suited.

The details in connection with the formation of a bridge in the manner spoken of need not be entered into, but it is suggested that the section of porcelain rod should be roughly shaped up to the desired form, both with regard to the body of the piece and outline of the teeth, and that the required additions be made by means of suitable porcelain body. As the fusing point of tube teeth and tube rods is 2300° F., most of the high-fusing bodies in common use may be employed.

In order to support and prevent the tendency to bending of a section of porcelain rod while it is being fused, an excellent plan is to insert a length of pencil lead into the tube before putting the piece into the electric furnace.

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